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THE PRICE OF COLONIAL DEVELOPMENT

THE recently issued annual report and statement of accounts of the Colonial Development Corporation for the year ended December 31, 1951*, raises even more forcefully than last year's report the question of the future of the Corporation and its place in Colonial development. That place was taken for granted in a debate on aid for under-developed areas in the House of Lords on May 21, when the emphasis, particularly in speeches by Lord Henderson, Lord Milverton, Lord Rennell and others, was laid on the importance of scientific and technical assistance in the development of such areas and on the demands which such development made on scientific and technical man-power. Lord Milverton quoted an estimate that about 150,000 trained men were now being turned out annually from universities, technical training colleges and trade schools in the Commonwealth countries of South and South-East Asia, and Lord Reading, replying on the debate for the Government, dealt with this aspect of technical assistance at some length, asserting that technical assistance meant increasing the degree of knowledge right down the scale to the actual foreman working on the job, and that we in Great Britain ought to be the main source of the experts required.

This need, Lord Reading continued, came at a time when our man-power was stretched almost to its limit; but there was special machinery in the Ministry of Labour for finding such experts as are required. A sub-committee of Lord Hankey's Technical Personnel Committee also was concentrating its attention on overseas requirements. Lord Reading remarked that a chief difficulty was to assure such specialists about their future on their return from posts abroad. The Government had agreed to release Civil servants, if necessary, on secondment, and industry and the academic world could also help by agreeing to the release of certain members of their staffs on generous terms. Men were required of a wide range of skills, and, most particularly, men of eminence and high calibre with a sense of vocation.

Lord Reading thought that Britain would be failing in its duty and at the same time losing something of its status in the world if such men could not be found; and, while the report on the Colonial Territories for 1951–52, issued afterwards, testifies to technical assistance which has been forthcoming for those areas from American experts, a welcome feature of that survey is the extent to which it indicates the man-power situation in the Colonial territories has been improved from British sources. The Colonial Development Corporation's report notes that specialists of various kinds, particularly in accountancy and tropical agriculture, are still hard to find for overseas work, but otherwise has little to say about the trained man-power situation, beyond emphasizing that the Corporation's policy is to employ local men and women where they are available. The high turnover of staff appears to be connected rather with

* Colonial Development Corporation. Annual Report and Statement of Accounts for the Year ended 31st December 1951. (Cmd. 167.) Pp. viii+74. (London: H.M. Stationery Office, 1952.) 3*s.* net.

the reorganization and reorientation still proceeding in the second year of Lord Reith's chairmanship.

For the rest, the House of Lords debate followed the lines of discussion on the strategy of world development given in a P E P broadsheet last year. Lord Reading emphasized the success of the Karachi Conference in convincing the countries of the region that greater emphasis should be placed upon agricultural production as distinct from industrial output, and referred to some of the large-scale irrigation schemes such as the Gal Oya project in Ceylon, for 130,000 acres with a hydro-electric scheme providing 75,000 kilowatts, the Bakhra–Nangal scheme in India, with one dam across the Sutlej River little smaller than the Boulder Dam in the United States, the £37 millions project in the Damadar valley, the Lower Sind Barrage scheme of Pakistan to give a further 1·5 million cultivable acres, and the Thal scheme in the Punjab affecting 2 million acres and including irrigation, land colonization and road development. While the debate emphasized the demands which Colonial development must make on the capital, as well as the man-power, resources of Britain, it scarcely emphasized as incisively as a recent series of articles in *The Economist* the price that has to be paid. Important as are certain technical difficulties in Colonial development, such as the improvement of transport facilities, the problem of land tenure and the supply of trained man-power, the crucial issue is that of finance. Where the Colonial territories are concerned, this must, in the main, come from Britain, and the restoration of the United Kingdom to economic health is a prerequisite to Colonial or to Commonwealth development, even side by side with aid from the United States.

In these articles *The Economist* insists that the first step for Colonial development is to create a larger margin of savings at home and a credit surplus on the balance of payments, and that this means reducing our level of consumption relatively to our output. This is the prerequisite to Commonwealth development, and the only alternative to such development is starvation and unemployment. Besides this realistic and harsh gloss on Colonial development, in the light of which the Colonial Development Corporation's report should be considered, there are now available the annual report on Colonial Affairs, 1951–52, already noted, and the Return of Schemes made under the Colonial Development and Welfare Acts in the same period. The report itself was fully debated in the House of Lords on May 28, and the future of the Corporation was a main subject of the debate in the House of Commons on July 17, while a Broadsheet (No. 343) on Colonial Development issued by Political and Economic Planning on July 7 discussed the future of the Corporation in the light of its annual report and the statement made by the Earl of Munster in the Lords debate on May 28.

Looking first at the report itself, the Corporation's operating loss for the year was £1,070,043, as compared with £524,917 in 1950, bringing the accumulated loss sustained by the Corporation in four years to £4,594,599, although for the first seven years the Corporation was relieved from paying interest on the money advanced by the Government. The losses were due, however, to the earlier more optimistic and grandiose activities of the Corporation before Lord Reith became chairman in November 1950. It is now claimed that the lessons have been learnt and that any suggestions for immediate large-scale development, such as the Gambia Poultry Farm, must be treated with particular caution. Stress is laid, too, on the way in which estimates have been overtaken in the past by rising costs, particularly in marginal schemes, and, other things being equal, the declared policy in future will be to look for experienced private enterprise partners to share in investment and in management. Schemes suggested by governments who meet the essential but financially unremunerative elements with their own or with Colonial Development and Welfare Funds, leaving the Corporation and its partners to take care of the rest, are to be consistently sought in future as one of the soundest lines of development.

On December 31, 1951, there were fifty-three undertakings in operation, with a sanctioned capital of £35,729,294. Besides the Gambia Poultry Farm, four undertakings were liquidated during the year, and the report expresses confidence that the end of a stage has been reached. Provided the Government brings its financial requirements into line with its basic intention, confidence can be felt in the Corporation, its purpose and its work.

For the second year in succession the anomalous position of the Corporation is emphasized, and the most significant section of the report is that which discusses the financial background to the Corporation's operations.

The Corporation is constituted to operate commercially; but its financial circumstances and conditions are at variance with commercial practice and purpose. The Corporation has no funds of its own, the Government providing capital for approved schemes in the form of long-term redeemable loans at rates of interest fixed by the Government. These advances have to be repaid, and the rate of interest has this year been raised again to 4¼ per cent, in place of the original 3 per cent. The report protests both against the raising of the rate, with the consequent difficulties in raising other loans or devising workable schemes, and against the impossibility of writing off losses. The result, it is suggested, must be to deflect the Corporation from its primary purpose of opening up new fields of development unless the Government affords some measure of relief.

The Corporation was not set up to compete with private capital but to supplement it, because there was obviously not enough private capital for the Colonial developments urgently required. Such development, however, implies adventure and risk, at least a long wait and a problematic return, and the report puts the issue bluntly when it says that the motive which established the Corporation was to do economic good but to do it without losing money. That motive, it is urged, is being frustrated by administrative action through the application of standard terms for long-term loans, because the

Corporation has neither the buffer of ordinary capital to bear the risks nor the ability to pass on its costs to the consumer, as does a public utility.

Lord Reith's plea was firmly rejected by the Government in the House of Lords debate on May 28, though the difference between the Government and Opposition in this matter appears essentially to be one of emphasis, rather than anything more fundamental, as Lord Ogmore suggested. Lord Ogmore places the emphasis on the Corporation's responsibility to do economic good and appears to think that the Government should be concerned chiefly to see that the Corporation does not force on the Colonial peoples schemes of development which they do not desire. On the Conservative side the emphasis is placed rather on the protection of the taxpayer's money. Both parties in principle agree to the existence of the Colonial Development Corporation. Neither seems disposed to face the fundamental issue and to ask those further questions about the purpose and methods of British Colonial development policy which, as P E P points out, quite rightly, are inescapable once we question the usefulness of the Colonial Development Corporation in its present form.

Lord Ogmore in the House of Lords debate advocated first a new financial policy in which the Corporation would be allowed to wipe out the accumulated losses and make a fresh start, and second, that the Colonial Office, Colonial Governments and authorities under the American Point Four Programme should use the Colonial Development Corporation as the agent for their pilot schemes. Other speakers in the debate, like Lord Rennell, Lord Balfour or Lord Perth, while agreeing as to the desirability of giving the Corporation a freer hand financially, welcomed the association of the Corporation with private enterprise, and Lord Rennell, in particular, urged the need for decentralization. The report itself declares the Corporation's intention of transferring in time full managerial, technical and financial responsibility for some undertakings to local people, and a possible solution to the problem of organization would be, as P E P suggests, to devolve responsibility on a number of regional corporations, each of which would be expected to break even after payment of interest, or to make no more than a specified loss if the financial regulations were thus relaxed.

There are plainly limits to the extent of such decentralization if a central corporation is to remain answerable for the regional corporations, nor can the possibility of functional devolution be dismissed without consideration. That method, which was discussed more particularly by Mr. R. Robinson in the House of Commons debate, might assist co-operation with other agencies concerned in the development of the backward areas but has its own difficulties, even if it should offer greater economy in the use of the available technical and scientific experts while the present shortage continues. Apart from Viscount Hudson, however, speakers in the House of Lords did not concern themselves with this question of functionalism and the most effective use of the scientific expert; but there was some fairly general concern expressed that under the present financial regulations the Corporation may be diverted from its original purpose of filling the gap between what private enterprise is doing in the Colonies and what is being done by the local resources of the Colonial governments and become little more than an investment trust to help private enterprise.

With the drop of nearly 20 per cent in the estimates for 1952–53 for Colonial development and welfare schemes to a total of £13 millions, compared with the original annual ceiling of £17·5 millions and the revised ceiling of £20 millions of the 1949 Act, the gap is likely to be the wider and the consequences of any diversion of the Corporation from its original purpose the more serious. The Earl of Munster's reply on May 28 summarized the Government's policy to the Corporation under five headings. First, the Corporation must be given more time to prove itself. Secondly, in present circumstances, and in the interests both of the Colonies and of the Corporation, speculative projects should be kept to a minimum. Thirdly, the Corporation should continue its efforts to put its own house in order. Fourthly, the Corporation is only one of the agents of Colonial development: it was set up to deal with commercial projects; other projects were the function of Government, through Colonial Development and Welfare and through local public funds. Fifthly, making capital available to the Corporation on artificially favourable terms could not be justified in present conditions.

On the policy of reorganization and caution, the Earl of Munster said further that, before large sums of money were advanced, the Government should attempt to satisfy itself that the Corporation had thoroughly examined all the pros and cons of any scheme, that it had made due allowance for any risks or contingencies, and that it was capable of implementing what it set out to do. Before any new scheme was sanctioned the Secretary of State would require sufficient information to enable him to judge whether a *prima facie* case had been made out. Further, except in special circumstances, someone else besides the Corporation should share in the risk, whether private enterprise or a local government.

The Government's intention to supervise the Corporation more closely, in spite of the Earl of Munster's reminder that the Overseas Resources Development Act laid firmly on the Corporation the sole duty of investigating, formulating and carrying out any projects, is confirmed by what the Colonial Secretary, Mr. Oliver Lyttelton, said in the House of Commons on July 17. Of Colonial development in general, Mr. Lyttelton admitted that over the next decade we would not have collected sufficient capital, although over the next three years this would not be the dominant factor: shortages of steel and of skilled labour, delays in importing machinery and the indifferent organization of local resources were likely to be the limiting factors.

Turning to the Colonial Development Corporation he reiterated the view that the Corporation was intended to act as a commercial concern and to pay its way, taking one year with another. Entirely uncommercial projects, such as much research and

experimental work, were outside the ambit of the Corporation, and the Corporation should not undertake projects which were unlikely to yield a gilt-edged rate. The Colonial Secretary then delineated more precisely the four criteria which would determine his approval of capital grants for the Corporation, at least one of which must be satisfied. He would inquire, first, whether the Colonial Government in the territory concerned was willing to participate if it had the money to do so; second, whether any local knowledge and experts had been mobilized, for example, on the board of the operating company in that territory; whether any local capital had been offered and accepted participation; and whether the Corporation had tried to associate itself with any company in the United Kingdom or elsewhere carrying on the same kind of business.

Exception can scarcely be taken to these criteria by those who have the interests of the Corporation and of the Colonial territories at heart; but it remains to be seen whether in practice they may not amount virtually to abolishing the Corporation. They do not dispose of the basic argument in the Corporation's report that its activities are already too severely confined by the financial rules which govern its operations, and the merits of a more vigorous policy and the ways in which such a policy could be pursued deserve closer attention than Government or Opposition spokesmen were disposed to give them in either debate. The P E P broadsheet already mentioned is of particular interest here. Apart from its close analysis of the activities of the Corporation and of the factors which inhibit both private investment in the Colonies and investment by a Government corporation, the broadsheet discusses the possibilities of new policies in this field.

The broadsheet frankly recognizes the difficulties on either side, and its discussion of such matters as the financing of experiments and pilot schemes is realistic. It finds no sound reason for the proposal to form a new organization for research and pilot projects, and while it does not insist as firmly as *The Economist* articles on the price to be paid for Colonial development and welfare, it points out clearly enough that the answer to be given to the financial questions regarding the Corporation's future depend both on the judgment as to how vigorous a policy the Corporation should pursue and the view taken of the broader issues of Colonial development. The right questions are asked, and the broadsheet is a contribution to the clearer understanding of the aims and methods of development without which no satisfactory policy can be framed. As the broadsheet comments, it is not much use to create institutions without any very clear idea of what they are intended to achieve. The dominant impression left by the recent debates is that, while both Government and Opposition wish to continue the Colonial Development Corporation, neither have any very precise ideas as to what it is intended to do, the real basis of selection of projects, of the relation of its activities to Colonial welfare and whether and how there should be closer collaboration with the Colonial Development and Welfare Fund.

FLUORESCENCE OF ORGANIC COMPOUNDS

Fluoreszenz organischer Verbindungen

Von Prof. Theodor Förster. Pp. 312. (Göttingen: Vandenhoeck und Ruprecht, 1951.) 32.50 D. marks.

FLUORESCENCE methods of estimation extend to much lower ranges of concentration than those based on light absorption, since the latter work by differences or ratios between light beams with and without absorption, whereas fluorescence, besides being very specific, is measured from a zero which can be made very low by paying sufficient attention to apparatus design. Within recent years the needs which have arisen in various fields to estimate very small quantities of certain vitamins, uranyl salts, aromatic hydrocarbons, etc., together with developments of photoelectric cells, electron multipliers and electronic circuits, have caused a number of fluorimeters to be put on the market. The result has been a great widening of interest in the subject of fluorescence, the mysteries of which have until lately been the cult of very few. On the basis of the reversible nature of light absorption, it might be expected that fluorescence would be a common and relatively simple phenomenon; it is, however, rare and easily affected by disturbing factors which provide many pitfalls for the unwary experimenter.

Prof. T. Förster's book is not immediately intended for the instruction of beginners in the avoidance of errors in measuring fluorescence; although practical methods are dealt with, commercial fluorimeters are not described in detail. It is a critical, accurate and up-to-date academic account for the serious student of each of the various aspects which have been explored by individual workers, with very complete references. The chapters include discussions of the relations of the structure of molecules and their power to fluoresce, the theoretical principles of light absorption and emission, fluorescence spectra, quantum yields, measurements of mean life before emission, polarization phenomena, and 'quenching'. For the practical worker, 'quenching' is a matter of the greatest concern; it refers to the reduction in the fluorescence of a solution due to rise of temperature, increase of concentration, or the addition of foreign 'quenchers'. Most molecules, which are not fluorescent, are 'quenched' by 'internal conversion', that is, the excitation energy is converted into molecular vibrational energy by a radiationless process formally explicable as a crossing of potential energy curves. The work of G. N. Lewis and Kasha has shown that in many cases this involves the intermediate formation of 'triplet' excited levels of long life and potentially important photochemical possibilities. Collisions with foreign 'quencher' molecules may also produce triplet levels, or may form radicals the photochemical reactions of which have been studied by Weiss and M. G. Evans. The relationship between triplet production and radical formation is a problem of great present interest. At very low temperatures and under appropriate conditions, triplet levels give a luminescence of their own, with a very long mean life, and affording new means of characterizing molecules which may never exhibit normal fluorescence.

Another interesting field in which Prof. Förster has himself made notable advances is that of resonance energy transfer between molecules. In crystals such as anthracene, and in solutions of

highly fluorescent substances, electronic energy may pass from molecule to molecule before radiation of fluorescence occurs. The distance over which such transfers take place may be as large as 50 A. or more, so that the effect may be observed in solutions of concentration 10^{-3}–10^{-2} *M*. Resonance transfer is of importance in the study of photosynthesis by chlorophyll in plants and in the use of fluorescent substances as scintillation counters for radioactive rays. After long hiding its light under a bushel, fluorescence is now being brought out into the daylight, and rapid advances in practice and theory may be confidently predicted.

E. J. BOWEN

TEXT-BOOKS OF ORGANIC CHEMISTRY

Organic Chemistry

By Louis F. Fieser and Mary Fieser. Second edition. Pp. xv+1125. (Boston, Mass.: D. C. Heath and Co.; London: George G. Harrap and Co., Ltd., 1950.) 7.50 dollars; 42*s*.

Organic Chemistry

By Dr. A. F. Holleman. Revised by Prof. J. B. Wibaut. Translated from the sixteenth Dutch edition by Dr. Samuel Coffey. Pp. xiv+660. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver Hume Press, Ltd., 1951.) 55*s*.

Organic Chemistry

By Dr. I. L. Finar. Pp. xv+696. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 40*s*. net.

MOST organic chemists have their own ideas concerning the perfect text-book for their subject, and a surprisingly large number possess the energy to bring their conceptions to fruition. As a result, students at all levels have a wide choice of guide to explore what Wöhler termed the "monstrous and boundless thicket" of organic chemistry.

The popularity of the first edition (1944) of the text-book by Prof. and Mrs. L. F. Fieser was due not only to its wide scope and up-to-date treatment but also to the clarity, readability and occasional humour of its exposition. These characteristics are retained in the new edition, which incorporates the significant advances of the past six years. Two major omissions in the first edition have been remedied with the introduction of chapters on reaction mechanisms (a triumph of well-written condensation) and on heterocyclic compounds. Space for these inclusions has been found by substantial pruning of previously over-written chapters (for example, steroids and quinones) and by adaptations of the format. Only one misprint could be detected, and the printing and binding are admirable. The pre-eminent usefulness of this book for all classes of student arises as much from its enthusiasm and feeling for the subject as from the attributes described above.

Roughly comparable in scope is the text-book of Prof. A. F. Holleman, revised and adapted by Prof. J. B. Wibaut; but the treatment tends to be old-fashioned and rather disjointed. Discussion of the usual homologous series is carried through with painstaking thoroughness; the more advanced topics are, however, treated much more cursorily. There are some startling omissions. The enormous advances in the separation of the constituents of protein hydrolysates are dismissed in four lines with no reference to paper chromatography. Again, in the section dealing with benzenoid substitution the concepts of inductive effect, mesomeric effect and hyperconjugation are not even mentioned; there is a similar lack of reference throughout to modern ideas concerning reaction mechanisms. It would not be inaccurate to classify the work as a present-day representative of an older type of text-book. The translation on the whole reads smoothly, although it is hoped that, in any future edition, the monstrosity "higherhydric" will be eliminated. The printing and binding are good.

The content of Dr. I. L. Finar's book is deliberately restricted to the basic groundwork of the subject and does not deal with topics such as the more complex natural products. Although thus limited in scope, the treatment is both complete and modern with full mention of the unifying physico-organic concepts. In particular, this seems to be the first organic chemistry text-book to include an elementary exposition on molecular orbitals, and recently introduced reagents and techniques (for example, lithium aluminium hydride) are discussed. The style is clear and readable, and the book can be recommended as providing a sound foundation for more advanced study.

R. A. RAPHAEL

TEMPORAL INTEGRATION AS A CLUE TO MIND

The Organization of Behavior

A Neuropsychological Theory. By D. O. Hebb. (Wiley Books in Clinical Psychology.) Pp. xix+335. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 32*s*. net.

SINCE its publication, Prof. D. O. Hebb's book has been widely and sympathetically discussed, and has won a place among the more notable contributions to current theory in physiological psychology. Its author was unusually well equipped for the ambitious task he undertook, namely, to formulate a theory of behaviour embodying recent developments in the neurophysiology of the brain as well as in experimental psychology itself.

Dr. Hebb allies himself at the outset with those theorists in psychology, sometimes called 'reductionists', who have no hesitation in introducing neurophysiological concepts to explain human behaviour. The 'non-reductionists' take the view that this cannot be done without injury to the psychological facts. Dr. Hebb attempts to safeguard himself against criticism from this direction by not denying or ignoring the complex facts of behaviour. He does not deal with mind by reducing it to the level of what is now known about the body; he rather suggests highly complicated forms of neural interaction which may help to explain what is now known about mind. Here his main contribution lies in his conception of *temporal* integration in cerebral activity. This conception has received strong support from the independent work of H. F. Harlow on 'learning sets' and of H. O. Mowrer on the persistence of self-defeating behaviour.

The theoretical gap which Dr. Hebb proposes to fill he attributes to the failure of neurophysiology to explain the events that occur in cortical transmission, that is, during the interval between the arrival of an excitation at a sensory area and its departure from

the motor area of the cortex. It is this failure which, in his view, has made it impossible for psychology to develop an adequate treatment of thought. He begins by directing attention to the apparent incompatibility between perceptual generalization, on one hand, and the stability of memory, on the other, and suggests a way out of this dilemma by effecting a compromise between configurationism and learning theory. At this point he brings in his distinction between perceptual unity and perceptual identity. The former—that is, the figure-ground relationship—he concedes to the configurationists, is sensorily determined and, so to speak, is 'given' in experience. The latter, he insists, is the result of learning. He is consistent in supposing that the mnemonic trace involves structural change and that perception depends, not on a pattern of excitation, but on the excitation of specific cells.

The theory of the book briefly amounts to the following. The more constant the stimulation from an object, the more readily it will be identified and so evoke a response. Repeated stimulation results in the formation of 'assemblies' of association-area cells, which facilitate other such assemblies. After stimulation has ceased, a cell assembly can act for a short time as a closed system and so prolong the interval during which structural change can occur. A series of cell assemblies produces a 'phase sequence', of which human thought is the most extended example. A phase sequence is a process that co-operates fully with external stimulation without being fully controlled by it, thus allowing for 'autonomous cortical processes' and for the psychological phenomena of expectancy and set.

The theory is developed in considerable detail, and, though it is speculative, the speculation is specific and thus renders it subject to the tests of observation and experiment as further evidence becomes available. Its usefulness in clarifying problems of perception, learning, motivation, and intellectual deterioration is a first step towards its verification. John Cohen

A REVIEW OF SCIENTIFIC INSTRUMENTS

Journal of Scientific Instruments

Editor: Dr. H. R. Lang. Vol. 28 and Supplement No. 1, 1951. Pp. xvi+388+iii+80. (London: Institute of Physics, 1951.) Bound, £3 12*s.*; unbound, £3.

THE *Journal of Scientific Instruments*, the monthly publication of the Institute of Physics, deals with the principles, construction and use of scientific instruments and is produced by the Institute with the co-operation of the National Physical Laboratory. When the *Journal* was started in 1923 it was the only periodical devoted to the subject of scientific instruments, and it soon obtained a high reputation among physicists and manufacturers of scientific instruments. This high reputation has been maintained through successive editorships. The present editor, Dr. H. R. Lang, the secretary of the Institute, has been responsible for Vols. 9–28, covering the period 1932–51. His task has not been made easier in recent years, first by war-time restrictions, then by post-war difficulties due to increased and continually rising costs of production, and, more recently, by the added responsibility of the publication of a sister monthly, the *British Journal of Applied Physics*. Nevertheless, a comparison of Vol. 28 with previous volumes shows that not only all the regular features and the high standard of the articles and book production have been maintained, but also that, in Vol. 28, the innovation of an attractive and informative supplement of papers on vacuum physics has been introduced. The editor and the advisory committee, under the chairmanship of Dr. R. S. Clay, are thus to be congratulated for their fortitude and their progressive attitude.

Vol. 28 contains four special articles, ninety-six original contributions, laboratory and workshop notes, reviews and notices of new books and descriptions of new instruments, materials and tools, in addition to the previously mentioned supplement. The range of subject covered is wide and most branches of physics are represented. Rarely does an author have more than one contribution; but Dr. Kantorowicz, formerly at the National Institute of Medical Research, London, and now at the Pametrada Research Station, Wallsend-on-Tyne, has no less than five laboratory and workshop notes in the volume. All the contributions are remarkably free from errors and misprints. Since quite a high percentage of the papers show by the dates of receipt that they required modification before final acceptance, it is suspected that the concise and effective form in which they appear is in no small part due to the conscientious and devoted manner in which the referees have carried out their arduous and voluntary task. It is a pleasure to record that the *Journal*, as it richly deserves, continues to prosper and that its circulation, both to members and non-members of the Institute, is on the increase. It is excellent value for the price. S. Weintroub

MAMMALS OF THE OLD WORLD

Checklist of Palæarctic and Indian Mammals, 1758 to 1946

By J. R. Ellerman and T. C. S. Morrison-Scott. Pp. vi+810. (London: British Museum (Natural History), 1951.) 65*s.*

ALL students of mammals welcome the appearance of this volume and are greatly indebted to the authors for their painstaking labour in providing a much-needed corner-stone in the structure of systematic mammalogy. The list, based on the unrivalled collections of the British Museum (Natural History), is not merely one of the working tools that every systematist must make for his own use but is also a critical revision of the mammals inhabiting an immense area of the earth's surface. It deals with mammals of the palæarctic and Indian regions, thus linking up with the already existing lists of the mammals of the Malayan and Ethiopian regions.

The authors give critical introductory paragraphs for each order and family, and indicate the diagnostic characters of each genus and species by reference to the appropriate works or by specially devised keys. The distribution of each species is approximately shown, though "it should be remembered that the distributions of many mammals are imperfectly known and that the ranges of many of the larger mammals are shrinking every year".

In the time covered by this revision, from the tenth edition of Linnæus to the end of 1946, an immense number of forms has been described. With the accumulation of adequate collections for critical

comparison it has become evident that many of the forms were separated and named on insufficient knowledge of their variation, and the authors are able to relegate a large number of specific and sub-specific names to the synonymy. They have, however, only indulged in 'lumping' to the extent justified by the evidence, and they believe that there is probably much more to be done; they have therefore arranged the sub-species in order of priority for the convenience of subsequent revisers. Nevertheless, the authors recognize no fewer than 809 species of mammals in the palæarctic and Indian regions as here defined.

Nomenclatorial difficulties are dealt with in a way that will commend itself to all right-thinking zoologists; the authors mention some of the works that have proved most troublesome, and list a number of names that they have submitted to the International Commission on Zoological Nomenclature to be placed on the "Official List". "There are workers who seem to take a delight in bedevilling zoology with esoteric changes of nomenclature. . . . Zoologists who discover a name which would cause confusion or inconvenience, though antedating a later but currently adopted name, should refrain from publishing their unfortunate find, and instead should hurry it off to the Commission for burial in the appropriate 'Index', at the same time requesting the Commission to place on the appropriate 'List' the later but currently used name. These are the principles which we have endeavoured to follow. . . ."

It is fitting that this book is dedicated to the memory of the late James Lawrence Chaworth-Musters, who had spent much time on the synonymies of the species of palæarctic mammals. The results of his patient and lengthy researches into the type localities and the dates of publication of species described in the eighteenth and early nineteenth centuries are incorporated in this volume, especially for the Insectivora, Chiroptera and Rodentia. Had Chaworth-Musters lived, he would undoubtedly have taken a large part in the work of preparing this list; his death was a great loss to systematic mammalogy.

The paper, printing and binding of this work leave nothing to be desired, and are fully in keeping with the high standard set by the publications of the British Museum since the end of the War. This splendid volume brings great credit to all concerned in its making.

L. Harrison Matthews

FLORA OF ARIZONA

Arizona Flora

By Thomas H. Kearney, Robert H. Peebles, and collaborators. Pp. viii+1032+32 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 56*s*. 6*d*. net.

ARIZONA, one of the largest of the American States, being almost the size of Italy with nearly 114,000 square miles, presents a wide range of topography. The land rises from almost sea-level to a plateau at an altitude of well over 12,000 ft. and includes the mile-deep Grand Canyon. The rainfall has a yearly average which varies from as little as three inches to nearly ten times that amount, while the frost-free period may be as short as three months or extending nearly throughout the year. In accordance with these variable conditions, the vegetation, while in general of a dry type, ranges from desert to evergreen pine forests. The environments provide a remarkable range of ecological conditions and support the flora of some 3,370 species with which this work deals, comparable in extent and diversity to that of the whole of France. Moreover, the flora embraces a considerable proportion of endemics, more than 160 in number. The vegetation is notable for the unusually high representation of three families, in particular the Cactaceæ, seventy-one species, the Euphorbiaceæ, eighty-four species, and the Polygonaceæ, ninety-four species. It is undoubtedly the desert vegetation for which Arizona is most famous, and especially the Cactaceæ, in which the area is so rich, including twelve species that are endemic. Of these cacti, *Carnegiva gigantea*, the State flower of Arizona, is the best known and the largest, attaining a height of fifty feet and possibly living for 150–200 years. Its fruits and seeds furnished food for the native Indians. At the other extreme, in respect to size, is the endemic and very local *Navajoa peeblesiana*, with rounded stems only 3 cm. high bearing spongy spikes. It is the members of the Cactaceæ that are mostly portrayed in the forty-five reproductions from photographs with which this work is illustrated.

The Euphorbiaceæ are represented by no less than forty-seven species of *Euphorbia*, while in the Polygonaceæ the genus *Eriogonum* is particularly rich with fifty-seven species. The largest genus in the flora is *Astragalus*, represented by more than seventy species, of which eight are endemic. Some of these are highly toxic because of their remarkable capacity for accumulating selenium from the soil. Others, too, though reported not to contain selenium, are nevertheless very poisonous and cause the famous loco disease of sheep and cattle.

Another well-represented genus in the Scrophulariaceæ is *Pentstemon*, with fifty-eight species, of which two are endemic. Needless to say, the flora includes a number of very peculiar types, not least curious being the parasite *Ammobroma sonoræ*, of which the only visible portion above the ground is the saucer-shaped receptacle bearing numerous small flowers that open in concentric rings.

The introductory matter of this flora provides a useful summary of the topography and climatic conditions and other aspects of the physiological environment, with a very brief account of the geographical elements that comprise the flora. The great bulk of the text consists of keys to the families, to the genera within each family, and for each genus a key to the species. No full descriptions are provided for the species themselves; but the information in the dicotyledonous key is somewhat fuller than such usually provides. In addition to this, the distribution of each species in Arizona is stated, together with its altitudinal range, the type of habitat, time of flowering, and the general geographical distribution. The proof of the full value of such a work must be its use in the field, and it is for the convenience of this purpose that more extended descriptions have been sacrificed. If one regrets that decision, it is largely because these condensed diagnoses whet the appetite for a full account of this fascinating flora.

The chief criticism that one has to level against this book is that the page headings have been entirely wasted. If, instead of merely "Arizona Flora" or "Flora of Arizona" which appear throughout on alternate pages of the text, the relevant order or genus had been cited, it would have greatly assisted the reader in converting a redundancy to useful information.

E. J. Salisbury

ARID ZONE RESEARCH

THE Advisory Committee on Arid Zone Research, set up by Unesco, recommended at its first meeting, held in April 1951, that special attention should be given to the collection of information and the discussion of problems concerning arid zone hydrology and particularly water supply. Thus on the Committee's advice, Unesco obtained and is printing a series of reports on hydrology and its problems in the arid areas of the world written by a number of authors, together with climatological maps of such areas.

Unesco in 1952 also organized, jointly with the Government of Turkey, a symposium on "Hydrology of the Arid Zone" which was held in Ankara during April 25–29. This conference was opened by the President of the Turkish Republic. Papers were given by representatives of about a dozen nations and dealt with: (1) the statics and dynamics of underground water; (2) its physical and chemical properties; (3) the hydrological balance and the effects of water utilization; (4) methods of prospecting for water; (5) the relation of hydrology to other sciences. Each of these subjects was introduced by a general review paper, after which papers were given on particular aspects of it. Many of the papers aroused considerable interest and provoked active discussion, and it was generally thought that the conference had proved very useful. Its proceedings will be published. Visitors taking part in the symposium received very kind hospitality from the Turkish authorities during and after the meeting. This included an excursion to part of the arid area of Central Turkey.

The Advisory Committee on Arid Zone Research also held its third meeting in Ankara in April. In its recommendations it followed its policy of giving priority to the collection, dissemination and discussion of information. Thus it recommended the preparation and printing of reviews of research on: (1) arid zone plant ecology; (2) sources of energy available in arid regions. Symposia on these two subjects were proposed for 1953 and 1954 respectively. On the Committee's recommendation, Unesco gave financial help to the Government of Israel in publishing the proceedings of its Symposium on Desert Research that was held in Jerusalem during May 7–14 (see below) and to the Institute of Biology (U.K.) to help towards the travel expenses of participants in its symposium on the "Productivity and Biology of Hot and Cold Deserts" that is to be held on September 25–27 next in London.

Unesco has asked its member States to appoint persons from whom advice may be obtained in a number of fields related to arid zone research. Such panels of experts have now been appointed by fifteen States and have already proved useful. The Committee recommended that this scheme be extended.

It also considered the preparation of a handbook that should give advice on the collection of basic data needed in planning the development of arid areas.

A scheme is now in operation in which certain research institutions, carrying out research in arid areas or concerned with their development, may be designated as suitable for the exchange of personnel and information and for the reception of visiting scientists. After considering their qualifications, the Committee recommended that the following institutions be added to those already designated. Particulars about them can be obtained from Unesco: (*a*) Fen Fakultesi Botanik Enstitusu (Institute of Botany, Faculty of Science), University, Ankara, Turkey; (*b*) Department of Botany and its Geobotanical Research Laboratory of the Negev, Hebrew University, Jerusalem, Israel; (*c*) Institut Français d'Afrique Noire, Dakar, French West Africa; (*d*) Jaswant College, Jodhpur, India; (*e*) Tohum Islah ve Deneme Istasyonu (Seed Improvement Station), Eskischir, Turkey.

The Committee considered the question of giving travel grants to men of science desiring to carry out research or make field studies abroad. It recommended that the Director-General might give such assistance in a limited number of cases provided: "(*a*) that the proposed research or field study comes within the scope of the Arid Zone Programme; (*b*) that the work is of importance to several Unesco Member States having arid and semi-arid areas; (*c*) that the results of the work will be freely available to the public; (*d*) that the request for transportation assistance by the individual is supported by the Unesco National Commission in his country; (*e*) that the individual has obtained approval for the research or field study from the appropriate authority at the institution or in the area in which the work is to be done".

On the research side the Committee recommended a small grant to assist in the study of the vegetation on certain nitrate- and sulphate-rich soils in South Algeria.

H. G. THORNTON

AN international symposium on "Desert Research", organized by the Research Council of Israel in co-operation with Unesco, was held in Israel during May 7–14. The growing interest in research devoted to various aspects of arid zones and their reclamation has been further stimulated by Unesco's activities, especially by the establishment of the Arid Zone Research Committee, and by the Unesco symposium on "Hydrology of the Arid Zone" (see above). The symposium in Israel was the first of its kind to be organized by a member-state of Unesco, and the first the programme of which did not restrict itself to one special subject of arid zone research but included several topics, and gave the opportunity for scientists in those fields of research to get an integrated picture of various aspects of desert research.

About fifty-five men of science from eighteen countries attended the symposium. At the opening ceremony in Jerusalem guests were welcomed by the Prime Minister, Mr. D. Ben-Gurion. Dr. Shen-Yi, chief of the Bureau of Flood Control of the U.N. Economic Commission for Asia and the Far East, brought the greetings of the Secretary-General of the United Nations, and Dr. F. J. Malina, of the Natural Science Department of Unesco, spoke on behalf of the Director-General of his organization. A short outline of the significance of the symposium was given by Dr. W. C. Lowdermilk, F.A.O. Adviser to the Government of Israel, who presided over the symposium.

Three days were devoted to scientific sessions in Jerusalem, the next three days to scientific excursions in the Negev, the Coastal Plain, and Galilee, and a final day to further scientific sessions in the Institute of Technology, Haifa.

Among the general papers were those by Leighly (United States) on "Dry Climates: their Nature and Distribution"; Kellogg (United States) on "Potentialities and Problems of Arid Soils"; Monod (France) on "Biology and Arid Regions"; and Bagnold (Great Britain) on "The Surface Movement of Blown Sand in Relation to Meteorology". According to Prof. F. B. Leighly, the extent of areas with a deficient water balance can be correlated with the wave-pattern of the mean isobars at a height of 3 km. above sea-level. Dr. D. Amiran (Israel) pointed out that the boundaries of semi-arid areas in Israel are continually shifting except where they are nearly fixed by the topography of the area, as in the Jordan rift.

There was complete agreement with Dr. E. C. Kellogg in his emphasis on economic and social factors in the utilization of arid and semi-arid soils, and interest in his view that in this area under-grazing as well as over-grazing constituted a danger with regard to soil erosion.

After a survey of the present position of biological research for arid zones by Prof. Th. Monod, Dr. R. A. Bagnold spoke on the mechanism of soil and sand transport by wind and explained his theory on the relation of the formation of sand ridges to the thermal structure of the atmosphere. Prof. C. W. Thornthwaite (United States) referred to some further data in support of Dr. Bagnold's figures.

Papers on climatology and meteorology in arid and semi-arid regions were read by Prof. P. Meigs (United States), Prof. C. W. Thornthwaite (United States) and Mr. S. Duvdevani (Israel). Prof. Meigs dealt with the preparation of homo-climatic maps, and showed in particular a map of Israel and Jordan. He discussed the parameters to be used in the preparation of these maps. Prof. Thornthwaite dealt with problems of water planning, stressing the importance of assessing potential evapo-transpiration, the amount of which can under certain circumstances be found by using phenological indications as accurately as by special measurements. The discussion on this paper was concerned with the uniformity of the water-storage capacity of soils, evapo-transpiration from various growths, and the use of atmospheric measurements to ascertain irrigation needs; for a first planning the nature of the crop is not considered of critical importance in assessing these needs. Mr. Duvdevani had measured the dew deposit on a prepared surface at various heights above the ground. The deposit at stations 1 m. or less above the ground depends on the topography, the soil and the season, and particularly on the water content of the uppermost layer of the soil; above a wet soil the deposit decreases upwards, above a dry soil it first increases and then decreases. The physical meaning of these measurements was raised in the discussion without conclusion.

Six papers were read in the Section on Soils. Prof. E. S. Hills's (Melbourne) lecture dealt with the relationship of physiography and climate, and with the influence of former physical conditions (as found from 'fossil' lateritic soils and sand ridges now bearing vegetation) and geomorphic features and patterns of natural drainage. The dramatically sudden and devastating effects of locally produced floods in desert areas was the main subject of Dr. W. C. Lowdermilk's lecture. Prof. A. Reifenberg (Israel), in a historic survey, showed the relationship of the encroachment of the desert to stable social conditions of government. Prof. G. Aubert (France) stressed how soils science had applications in the planning of irrigation, and Prof. S. Ravkovitz (Israel) dealt with the wind transport of soil material; according to him the salts in the loess soils in the Southern Desert of Israel were probably wind-borne from the Dead Sea. Dr. G. Leone's (Italy) lecture on the stabilization and re-vegetation of coastal dunes of Tripolitania introduced a discussion which stressed a similar state of affairs in this respect in the whole Mediterranean area.

The lectures in the Section on Biology were many-sided, embracing human physiology, general ecology, zoology and phytology, all with emphasis on desert environment. Dr. W. S. Ladell (Nigeria) gave a review on the physiology of life in high ambient temperatures which included the result of his research during the past ten years. He stated that Europeans temporarily resident in a tropical climate learn to tolerate severe heat with less discomfort than the local inhabitants. He refuted the theory that warm climates are detrimental to health and to productive work. He held the view that white settlers in hot regions had succumbed, when they had succumbed, to disease rather than to climatic factors. Ladell also discussed the physiological changes in the course of acclimatization to heat, the role of sweat and chlorine loss and of the central regulation mechanism involved. He stressed the point that in order to become acclimatized one has to expose oneself and not carefully to avoid exposure. Prof. F. S. Bodenheimer (Israel) spoke on the physiology of animals in arid zones with special reference to the frequent occurrence of dark and black colours.

Prof. F. W. Went (United States) spoke about the different germination mechanisms of desert plants which inhibit their germination at the wrong temperatures or after insufficient rains. He stressed the role of water in the germination of desert annuals. When the soil was kept wet all the time no germination occurred for many species. The reason for this lies in the presence of germination inhibitors inside the seeds, which are not leached out by small amounts of precipitations. With too much rain not only the inhibitors but also a growth-promoting substance is leached out. The inhibitors are formed continuously as soon as the seeds are wet. Dr. H. G. Thornton (Great Britain) dealt with his new approach to microbiological research work on desert soils, and Prof. Ch. Killian (France) gave a description of the vegetation of the Chott Hodna (Algiers) and analysed its edaphic conditions. The results are indicator values of the various plant communities, particularly with regard to chemical properties. Dr. B. T. Dickson (Australia) and Dr. P. C. Duisberg (United States) dealt in particular with plants in arid and semi-arid zones, Dickson with the Australian experience of transplanting plants into Australia, and Duisberg with the commercial utilization of desert plants from North America. Afforestation in arid areas was the subject of Sir Harold Glover's (Great Britain) lecture, which contained advice for planting, seeding and felling in such a way as to minimize the encroachment of the desert. Prof. M. Even-Ari (Israel) gave a short account of the water balance of desert plants, especially their adaptation to the dry season by decreasing their transpiring surface. Dew formation and active condensation of water vapour out of the atmosphere possibly constitute additional water sources for these plants. In the discussion, Prof. Went pointed out that the real suction forces of plants are apparently much stronger than those

obtained by cryoscopic measurements of osmotic values.

Prof. A. Bonne (Israel) and Dr. M. Ezekiel (F.A.O.) presented the point of view of the economist and explained the importance both of economic planning and of general economic and statistical surveys of food requirements. Prof. M. R. Huberty (F.A.O.) explained the structure and purpose of the Food and Agriculture Organization with special reference to its activities in the field of ground-water studies.

Introductory to the excursions, Mr. P. L. O. Guy (Israel) gave an account of the remnants of the soil and water conservation service which existed in the Kurnub upper-catchment area during the Byzantine period and suggested that the site should be rebuilt as an experimental reserve; Mr. A. de Leeuw (Israel) outlined the overall irrigation scheme for Israel with special emphasis on the problem of water storage.

In the session held in Haifa, Mr. E. W. Golding (Great Britain) told of recent British experience on the utilization of wind-power for the generation of electricity by windmills of modern type, and gave a general discussion on the economic exploitation of wind energy with particular reference to this region. The remaining papers of the last day dealt with problems of ground water and water in soils. Dr. P. Danel (France) dealt with the physics and the measurements of the flow of ground water and with the application of the methods of measurement which he and his co-workers in Grenoble had developed. Dr. L. A. Richards's (United States) papers also dealt largely with the technique of measurements, in this case with the physical properties of soils, especially as regards their power to retain water. The relevance of such measurements to irrigation methods was discussed, as well as the foundations of the new subject of soil physics. The paper of Dr. A. N. Khosla (India) was read by his colleague, Dr. R. D. Dhir, and dealt with the relation of surface water and ground water in arid zones. He gave a simple formula which he has applied successfully to several catchment areas in India to determine the yearly run-off from catchment areas. The formula is based on monthly average temperatures only. In the discussion it was pointed out that Dr. Khosla's method may be correlated to Thornthwaite's method of evapo-transpiration. Prof. L. Picard (Israel) reviewed the history of ground-water investigations, and Dr. M. G. Drouhin (Algiers) spoke on hydrological studies in desert regions.

In the closing session Sir Ben Lockspeiser (Great Britain) summed up his impressions of the conference, followed by a discussion to which, among others, Kellogg and Monod made valuable contributions. It appears that the main lessons to be learned from this symposium are as follows: (1) Desert research requires many disciplines, and although men of science usually prefer to talk to specialists in their own discipline, a conference of this type bringing together the various experts dealing with arid zones is valuable and should be repeated every four or five years. (2) In all the branches men of science are still struggling to clarify their ideas; in some of them even commonly accepted definitions and terminology are still lacking. Nevertheless, (3) the biggest hindrance to progress at the present time is the lack of available data in branches where there is common agreement on which data should be assembled, and there are generally accepted techniques for assembling them. This is true particularly for soil and water studies and also for certain specialized meteorological data. The members of the conference unanimously accepted the following resolutions:

"This symposium wishes to draw the attention of the Director-General of Unesco to the following resolutions:

"1. That interested Governments be invited to strengthen existing research devoted to various problems of arid zones at existing national centres with a view to (*a*) encouraging fundamental research, and (*b*) the eventual creation of national bodies where the practical problems of each area can be brought to a focus and considered as a whole.

"2. That the effort devoted to field surveys, undertaken to obtain the basic data on the arid zones, should be extended and means provided for increased training facilities for technical personnel required for field studies and operations.

"3. The symposium attaches great importance to the exchange of scientists and the sharing of training facilities on an international basis.

"4. The symposium appreciates the practical interest and support of arid zone research and development of the United Nations, its Specialised Agencies and of international non-governmental scientific organizations, and warmly supports the recommendation of the Advisory Committee on Arid Zone Research that Unesco should initiate steps for the preparation of a handbook to guide collection of basic data".

The proceedings of the symposium will be published by the Research Council of Israel with financial support by Unesco.

S. Goldstein

THE SCIENCE OF DOMESTIC HEATING*

THE subject of domestic heating is of particular interest at the present time in Great Britain when the quantity of coal for use in homes may well have to be reduced as a result of both the ever-increasing demand for coal to satisfy the expanding power requirements of industry and the urgent economic need to export more coal.

Coal must continue to be the principal domestic fuel in Britain for many years to come, the supply of alternative fuels being totally inadequate for this purpose, so that there is every incentive to improve heating methods and appliances with the view of obtaining more heat and comfort from less coal. Furthermore, the greater scarcity of coal and its rising cost, together with an advance of scientific techniques and equipment, have given an added impetus to a more scientific approach to the problem during recent years.

The chimney fireplace was first introduced into England during Norman times and was the beginning of the familiar open fire of to-day. The early chimneys were large and troublesome; but their size was reduced only slowly, and it was not until Rumford suggested a narrowing of the throat of the fire, to reduce room draughts and to combat down-draught, that any marked improvement occurred. A further restriction of the throat, with consequent additional advantage, followed upon the introduction of cast iron as a

* Summary of a Friday Evening Discourse delivered to the Royal Institution on May 16 by Mr. J. S. Hales, of the British Coal Utilisation Research Association.

material of fireplace construction; but this advance was lost later when the tile surround became popular and precluded the use of proper throat control. Cold draughts increased again, furnishings and clothing became lighter, and comfort decreased once more.

It is not always appreciated that, of the heat available in coal burned in an ordinary stool-bottom grate in a tile surround, only some 20–25 per cent is emitted as useful heat in the form of radiation. Of the remaining heat, up to 20 per cent passes into the brickwork of the fireplace, and the rest is lost in the flue gases, which include smoke, and in any unburned fuel in the ashes. If the chimney is on an inside wall, a proportion of the heat lost into the brickwork and in the flue gases may be regained, but the amount is small because of the low temperature of the flue gases, caused by their admixture with excessive air drawn into the unrestricted throat of the fire. Attempts have been made, from the seventeenth century onwards, to make better use of the heat which passes into the brickwork of an ordinary open fire, usually by the design of so-called 'convector' fires, in which the fire is partially enclosed within a metal casing. Air circulates through the annulus so formed, and is heated before re-entering the room. Modern types of convector fire are continuously burning and incorporate underfloor air-control for the rapid revival of 'dead' fires.

Although comparatively inefficient, the open coal fire has the redeeming feature of attractiveness, which is doubtless the principal reason for its retention in homes. To be fully acceptable, however, the open fire must provide an optimum degree of comfort combined with an economical use of coal.

Comfort may best be defined as the simulation indoors of the outdoor conditions on a calm, sunny day in spring—namely, a source of radiation, a moderate air temperature, no excessive air movement and a reasonable humidity of the air. The economical attainment of this degree of comfort demands that greater attention be paid to existing methods of house-building. A source of radiant heat alone cannot give the desired room air temperature, while purely convection heating, which tends to require the maintenance of high air temperatures, leads to a high heat loss and consequent heavy fuel consumption in the vast majority of present-day British houses. This heat loss can only be reduced by careful insulation of walls, ceilings and windows, and by the exclusion of unnecessary draughts. Unfortunately, satisfactory insulation is impossible in most existing houses, so that a compromise between solely radiant and purely convective heating methods needs to be effected.

Such compromises have been proposed for as long as two hundred years, for the *cheminée de Nancy* was in effect an open fire which provided convection heating also. Modern appliances still seek to provide radiant and convective heating, and also to reduce the air flow up the chimney to the acceptable figure of about 2,500 cu. ft./h. for average rooms and occupancy.

The many earlier proposals for better house-heating may have been neglected because of a lack of proper testing equipment and facilities. These difficulties are now being removed, however, and in modern research into methods of domestic heating use is made of such instruments as the integrating radiometer, the continuous-recording balance, and the recording anemometer for the simultaneous measurement of the radiation, rate of fuel consumption and air flow, respectively.

The outstanding problem of domestic fires, and one which will remain as long as coal is the chief fuel, is that of reducing or eliminating smoke emission. From the time when coal was first used as a fuel, suggestions have been made for reducing smoke, many of which require the smoke to pass through red hot cinders before its escape. Devices of this kind undoubtedly reduce smoke, but are difficult to develop as a controllable home appliance. Nevertheless, the attack on smoke has received added impetus from the recent development of precise measuring equipment, such as the thermal precipitator which measures the rate of deposition of tar or soot from flue gases.

The use of instruments of this type and those mentioned earlier, together with the application of modern techniques, should lead to a more rapid improvement in our methods of domestic heating which will remove many of the current criticisms to which we are subjected.

BRITISH COLONIAL TERRITORIES, 1951–52

THE survey "The Colonial Territories 1951–52"*, which includes the usual chapter on research and surveys, again precedes the annual report on Colonial research and provides the essential background against which the recently published "Return of Schemes" made under the Colonial Development and Welfare Acts 1951–52 (see p. 311), and the annual report, "Colonial Research, 1951–52", still to appear, should be appraised. Considerable emphasis is again laid, in the general survey forming Part 1, on political developments, notably the new policy in Malaya, and the problems connected with closer association in Central Africa and with the coming into force of the new Nigerian constitution; but, on balance, the main emphasis in the survey for this year is on economic matters. Financial stringency, for example, and the need to husband funds available for research schemes under the Colonial Development and Welfare Acts, have led to a marked decline in the number and size of research schemes made during the year; but some £1,231,000 was disbursed on such schemes during the year.

Recommendations by Colonial Governments for inclusion in the Colonial Research Service of more than sixty specialist and research posts in departments of agriculture and in veterinary services have been approved; some twenty new appointments were made on Colonial Research Service terms, and fifteen research studentships awarded. Nevertheless, there were still 988 vacancies in the Colonial Service in spite of 1,396 appointments during the year, and, of these vacancies, 281 were in the educational service, mainly for teachers of scientific and technical subjects and for primary teachers. Only 141 civil engineers and 68 mechanical engineers were recruited as against 169 and 70, respectively, during 1950, but 169 medical practitioners were recruited as against 131 for the previous year. The planned expansion of the Colonial Geological Surveys is now almost complete, with an overseas staff of 180, compared with 58 in 1947. In this field valuable help has also been given by United States and Canadian geologists, chemists and mining engineers under a scheme of the Economic Co-operation Administration, and, besides an increase

* Colonial Office. The Colonial Territories, 1951–52. (Cmd. 8553.) Pp. x+140. (London: H.M.S.O., 1952.) 4*s.* 6*d.* net.

in the total area geologically mapped during the year, continued progress is reported in the investigation of mineral deposits as well as in the discovery of water supplies. The growing interest of the universities in Colonial geology is also proving of practical value. A party of field surveyors, including three Americans recruited by Economic Co-operation Administration, has reconnoitred by geodetic triangulation from eastern Uganda (near Mount Elgon) down the east side of Lake Victoria to Tanganyika and also measured a base near Kisumu. Geodetic triangulation continued in Basutoland, and the Royal Air Force maintained its air-photography programme in Central and East Africa.

In Zanzibar the work of the team investigating the disease of cloves which threatened the industry with extinction is showing fruitful results. It is now confirmed that the death of young clove trees and the 'die-back' of older clove trees is caused by a parasitic fungus, and there is evidence that 'sudden-death' disease is caused by another fungus. It is expected that methods of control will eventually remove the threat to the economy of the territory, and during these investigations the team also determined the cause of a disease of coconuts. Work with systemic insecticides at the West African Cocoa Research Institute promises to provide a useful adjunct to the method of controlling the 'swollen-shoot' virus disease by cutting out diseased trees.

The survey gives some figures which should be kept in mind in considering the expenditure of £14 million during the year from Colonial Development and Welfare Funds. During the year the dollar surplus of the Colonial territories was 455 millions, 330 millions of which accrued during the first half-year. Development plans adopted during the year include the £75 million plan for the Gold Coast, which does not include the Volta River project, the publicly owned parts of which are estimated to cost a further £65 million with an expenditure by private enterprise of £40 million on the aluminium industry. In the Gold Coast plan, which is to receive £3 million from Colonial Development and Welfare Funds, some £48 million coming from local resources, 17 per cent is to be applied directly to increasing productive capacity in agriculture and industry, 35 per cent to communications and 33 per cent to social services. The revised plan of the Kenya Government for the ten years ending in 1955 contemplates expenditure of £35 million compared with the previously approved £20 million, and here also emphasis is placed on measures designed to improve the agricultural industry. Development plans approved up to March 31, 1952, totalled £456 million, against which £78 million was to come from Colonial Development and Welfare Funds.

Special attention has been given to the problems of mechanization of agriculture in Colonial territories, and the plague of the desert locust (*Schistocerca gregaria*) is being energetically combated by modern mechanized methods in Somaliland Protectorate, Aden Protectorate and Kenya, which is the main danger area; and to co-ordinate such campaigns with those of other countries, a Technical Advisory Committee on Desert Locust Control has been set up to advise the United Nations Food and Agriculture Organization. The urgency of developing the livestock industry has focused attention on the best methods of cattle breeding; a survey of cattle-breeding policy and research was undertaken in the African territories during 1951, and the report is now under consideration. There are now fifty fisheries officers serving or in training, and a feature of the year has been the promising results obtained in fish-farming in the West Indies and in East and West Africa. Supplies to the Colonial territories were adversely affected during the year by world shortages, particularly of iron and steel semi-manufactures, non-ferrous metals and chemicals which contain sulphur. United Kingdom exports of semi-manufactured steel to Colonial territories could not be maintained at the 1950 level.

With regard to education, the survey reports that almost all the buildings in the first programme of the University College of the West Indies will be in use during this year; at University College, Ibadan, in Nigeria, three halls of residence, the science laboratories, arts block and administration building will be occupied in October this year, and the Nigerian Government has granted £1·5 million for building a new teaching hospital. Courses began last January at the two new colleges of arts, science and technology, to be known respectively as the Kumasi College of Technology and the Nigerian College of Technology, while work has started on the new buildings of the Royal Technical College, Nairobi, which will serve all the British East African territories. Studies of educational policy and practice in West and in East and Central Africa were initiated, and the findings of the two missions are to be discussed at a conference later this year. An accelerated Development Plan for Education in the Gold Coast was published during the year, and extra-mural departments have been firmly established at the University College of the West Indies and at Ibadan. To meet the need for trained teachers while training institutions are being built up in Malaya, the Malayan Teachers' Training College, at Kirkby, near Liverpool, was opened as a short-term project. Besides the 3,417 students at the Colonial universities and university colleges, there were more than five thousand Colonial students in Britain.

In the health field, the Medical Departments of the African territories are now up to establishment for medical practitioners, except for a few officers with special experience or qualifications such as pathologists, but in Malaya many vacancies remain. The training of medical auxiliaries is receiving high priority, and the many schools for training locally pharmacists, laboratory assistants, radiographers and physiotherapists are working to capacity. It is hoped that the rural health centres which are being developed will soon be playing as important a part in the life of rural communities as does a hospital service in urban areas. Tuberculosis is now perhaps the greatest socio-medical problem in the Colonial territories, and efforts to tackle this problem have been intensified during the year, including the active exploitation of B.C.G. vaccination; but in the absence of specific drugs or rapidly effective preventive measures, success is likely to be slow and costly. In leprosy, however, successful treatment by the most modern drugs has completely changed the outlook, and in this work missionary bodies and voluntary organizations have played a conspicuous part. Malaria remains the most universal menace to health, and its complete eradication has so far proved possible only where favourable conditions exist. Total elimination has been maintained in Cyprus, and in Mauritius the incidence has become negligible, although *Anopheles gambiæ* has not succumbed so readily to the residual spraying technique which was rapidly lethal to the principal carrier, *Anopheles funestus*. Some eight hundred

Colonial student-nurses are taking general nursing, mental nursing or midwifery courses in the United Kingdom.

A chapter on international relations, besides giving a picture of the extent of technical co-operation both through the Specialized Agencies of the United Nations and in other ways, gives a clear account of Great Britain's relations with the Trusteeship Council and of the reasons which led the United Kingdom to oppose two, and abstain from five, resolutions in the discussion by the Fourth Committee of the General Assembly of the report of the Committee on Information from Non-Self-Governing Territories. This is but a single illustration of the way in which this survey of Colonial territories is an invaluable contribution to the discussion of Colonial affairs in general or to the consideration of Colonial development and welfare schemes, and it forms a very useful guide to the scientific and technical work which is reported more fully elsewhere.

NEWS and VIEWS

Faraday Society: Prof. J. W. McBain, F.R.S.

THE Faraday Society has elected Prof. John William McBain an honorary life member. Prof. McBain has held the chairs of physical chemistry in the Universities of Bristol in Great Britain and Stanford in the United States, and after his retirement from Stanford was for a time director of the National Chemical Laboratory of India. Prof. McBain's contributions to colloid science and surface chemistry are well known; he was the first to undertake a comprehensive study of the constitution of soap solutions, and is universally recognized as the discoverer of the ionic micelle and a pioneer of the science of colloidal electrolytes. In this work he has been ably assisted by his wife, Mrs. M. E. Laing McBain. His experimental verification of Gibbs's adsorption equation, by slicing off a very thin layer from the surface of a solution, and comparing the concentration of solute in this layer with that in the bulk solution, stands out as one of the boldest experimental researches in physical chemistry of the last quarter of a century. He was awarded the Davy Medal of the Royal Society in 1939.

A Meteor Train

DR. A. R. HOGG, chief assistant at the Commonwealth Observatory, Mount Stromlo, Canberra, writes that a spectacular meteor train was seen during the course of photometric observations at the Commonwealth Observatory. The train first appeared on May 4 at 19h. 15m. G.M.T. (05h. 15m. E.S.T.) against a dark sky. For a few seconds it had the likeness of a comet's tail, about 5° long. This similarity soon vanished and within thirty seconds of formation the train was a straight line. In a further half-minute the top third of the line apparently bent northwards a distance of about 2°. Subsequent changes were more gradual. Fifteen minutes after formation the train was visible as a faint diffuse horse-shoe-shaped glow centred 2 or 3° higher than the original train. Thirty minutes after the formation the area was searched with a wide-field telescope of 5-in. aperture, but no trace of the train could be seen. The angular dimensions were estimated from sketches made at the time, and reference to the background of identified stars. This gave the position of the centre of the train as near R.A. 14h. 40m. and Dec. 37° S. (1950). If it be assumed the meteor first appeared at the average height of such objects (100 km.), the train was about 20 km. long and distant 140 km. from the observer on a true bearing of 245°. At this point it would not have been illuminated by direct sunlight. The distortion of the train in the first half-minute represented a component of motion at the 80–100 km. level of at least 480 km./hr. moving to the north. From the date of appearance and direction of the train the meteor could have been a member of the Gamma Aquarii shower.

Scintillation of Stars and the Atmosphere

A RECENT issue of the *Irish Astronomical Journal* (1, No. 8; December 1951) contains, among others, a paper on "Scintillation and Atmospheric Seeing", by H. E. Butler, of Dunsink Observatory, which gives an excellent account of the reasons for this phenomenon. The study by means of a photoelectric cell of the most rapid fluctuations present in the light from a star has been carried out at Dunsink. The equipment will record fluctuations in the light intensity at frequencies between 0 and more than 1,000 c./s., and very interesting results are shown graphically on a plate. Besides its astronomical applications, there is also the meteorological significance, because the amount of scintillation at any moment could be a measure of the amount of turbulence that is present at the time in the telescope beam. It has already been shown that considerable changes in the scintillation can occur with changing weather.

Research on the Constitution of Alloys

THE Constitution of Alloys Group of the British Iron and Steel Research Association has recently issued a statement dealing with the principal gaps in current research on alloys constitution and indicating its willingness to encourage and assist such research. The alloys that have been insufficiently studied are as follows: high-temperature materials, and, in particular, higher-melting-point alloys of Groups V and VI, systems containing borides, and ferrous alloys containing silicides; ferrous alloys in general, and, in particular, the binary alloys of iron as a basis for further studies of the complex equilibria involved in ternary and quaternary alloys, and also the relationship between the various carbides in alloy steels; magnesium alloys, their heat treatment, and especially the ternary and more complex alloys; high-tensile brass-type materials and the complex bronzes; and finally, general work on the physics of alloys, especially the crystal structures of intermetallic phases and accurate measurement of lattice spacings. It should be noted that by enumerating this list of topics no implication is intended that other subjects and systems in metallurgical research are of lesser interest or do not merit so much study. The Group would also be glad to know of existing equilibrium diagram work which has not been reported to it, and of projected research programmes involving the constitution of alloys. Those interested should communicate with the Secretary, Constitution of Alloys Group, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Fluorescent Lighting in Museums

An important article in the April issue of the *Museums Journal* (reprinted from *Museum*, 5, No. 1, March 1952, by permission of Unesco) by M. J. Genard, of the University of Liège, on "Extreme Ultra-Violet Radiation from Tubular Fluorescent Lamps and its Effect on Museum Lighting", deals with a subject of great interest to all those concerned with the preservation of objects exposed to artificial light. The paper opens with an admirable survey of the principles involved in fluorescent lighting. Details are then given of the research work of the author and other investigators, from which it appears that radiation from tubular fluorescent lamps in the ultra-violet zone of the spectrum between 310 and 400 mμ is not more injurious than the corresponding radiation from incandescent lamps or sunlight, as long as the conditions of illumination and atmosphere are identical. On the other hand, it is known that the 254-mμ ultra-violet radiation of mercury causes intense photo-chemical reaction in many materials. It would therefore seem probable that there is a region of the spectrum in this vicinity which is to be regarded as particularly dangerous. Tubular fluorescent lamps emit an ultra-violet radiation extending as far as 280–290 mμ in the short wave-lengths. It is feared that these radiations may accelerate photo-chemical deterioration in view of the very marked deleterious action of the neighbouring zone of the spectrum. Neither sunlight nor the light of incandescent lamps contains ultra-violet elements of such short wave-lengths as those found in the light of fluorescent lamps. It is also established that the continuous radiation, due to the fluorescent powders used in certain types of tube, sometimes extends into these extreme wave-lengths. It is to be feared that these types may be more harmful than the others. The transmission curves of the glass in existing varieties of fluorescent tube differ little one from another. It should, however, be possible to use glass which absorbs all rays below 320 mμ. After a tube has been in use for a thousand or so hours, the extreme ultra-violet radiation is approximately 25 per cent less.

National Central Library : Annual Report for 1950

The thirty-fifth annual report of the executive committee of the National Central Library covers the year ended February 28, 1951 (pp. 35; from the Library, Malet Place, London, W.C.1; 1951). Building operations for the reconstruction of the building in Malet Place commenced in October 1950, and it was expected that the west wing and much of the east wing would be ready for occupation in June 1951. The Treasury grant for the year was increased from £22,500 to £25,000, of which £1,000 was to compensate for the third stage in the discontinuance of the contributions from the Carnegie United Kingdom Trust. These, since 1916, have totalled £293,786, including £84,500 to outlier libraries and £41,499 to regional library systems for the compilation of union catalogues, and the report includes a warm acknowledgment of the value of this generous support. There has been a good response from all types of libraries to the trustees' appeal for increased financial contributions, and such contributions were 39·5 per cent higher than those from similar sources during 1948–49. Issues of books from or through the Library during the year decreased by 2,332 to 94,220; but applications increased to 92,740 from 87,931 during 1949–50, the percentage of applications successfully handled being 65·3 as against 71·49 during 1949–50. Issues to university libraries again increased, by 5·42 per cent, to 13,479, while the calls on university libraries for the more specialized books and periodicals also continue to increase. Issues to outlier libraries increased by 20,271, and other special libraries lent a total of 1,810 books to meet special needs: fourteen further libraries were added to the list of outlier libraries during the year. Issues from the Scottish and Irish Central Libraries, however, decreased to 12,616 and 11,959 respectively, as compared with 15,397 and 12,493 in 1949–50. A total of 609 libraries co-operating in the regional system and the London Borough libraries inter-lending system lent 170,979 volumes to other libraries within their own system and 24,865 books to libraries in other regional systems or to non-regional libraries through the National Central Library, as compared with 164,152 and 21,423 in the previous year. Books lent through the international lending service rose from 994 (twenty-three countries) during 1949–50 to 1,587 (thirty-eight countries), and books borrowed from 420 (nineteen countries) to 584 (nineteen countries). Less time was spent on cataloguing Russian books and periodicals; but 4,899,620 entries have now been supplied for the national Union Catalogue.

Science in Latin America

Four publications have appeared of late which chronicle contemporary scientific activities in Latin America. Three of them, which form part of the very comprehensive series of lists published by the Unesco Science Co-operation Office for Latin America, are entitled as follows: "Venezuela, Vol. 1" (pp. 131) and "Brazil, Vol. 3" (pp. 230) of the list of "Scientific Institutions and Scientists in Latin America", and "Latin American Contribution to Scientific Progress: Chemistry, 1948–49" (pp. 50). The fourth volume, published by the Ministry of Education of the Argentine, is a "Compilation of the Bibliographies in the Library of the Faculty of Agronomy and Veterinary Science of the University of Buenos Aires" (pp. 30). The two publications dealing with Brazil and Venezuela follow the familiar pattern adopted for other Latin American countries (see *Nature*, 165, 589 (1950); 166, 1059 (1950); 167, 972 (1951)), and their scope is indicated by their titles. The volume on chemistry is one of a number of reports which it is intended to publish every two years, for the purpose of making known the Latin American contributions to the progress of science; the text, in English, gives abstracts of the work, grouped under topics, and a bibliography of papers. The fourth work, though theoretically restricted to papers and books in the field of agriculture and veterinary science, liberally interprets this restriction to mean any publication in science and engineering with a bearing on the field in question; it is sub-divided by subjects, and within each subject the contents are listed alphabetically by author.

National Institute of Economic and Social Research : Report for 1951

The National Institute of Economic and Social Research, which was founded in 1938 as an independent non-profit-making body, has as its object the propagation of knowledge of the social and economic conditions of contemporary society. In its report for 1951 (pp. 32; from the Institute, 2 Dean Trench Street, Westminster, London, S.W.1; 1951), it is explained that the activities of the Institute are

now to be directed largely to research into industrial and commercial capital, and inquiries have already been started into the finance of public companies and the stock of capital assets. Among previous research projects now nearing completion are investigations into trends in retail trading, consumers' expenditure and behaviour during 1920–38, and the location of industry. The inquiry into trends in retail trading traces the changing pattern of retail trading during the past fifty years or so, with particular attention to the development of multiple-shop and co-operative retailing. The project dealing with location of industry was undertaken by the Institute on the invitation of the Board of Trade for the purpose of investigating the private costs of firms which have opened branch manufacturing plants. An interim report was presented to the Board of Trade in 1950 in which the costs of the branches were compared year by year with those of the parent factories. On the basis of the work already done, it is hoped to establish the cost of mobility in certain industries and to assess the relative importance of various location factors in these industries.

Fifth Plant Breeders' Conference

THE fifth Plant Breeders' Conference under the auspices of the Agricultural Research Council was held during July 24–26 at the John Innes Horticultural Institution, Bayfordbury. Prof. K. Mather and Dr. E. E. Cheesman represented the Agricultural Research Council. Dr. C. D. Darlington was in the chair. The scope of this year's conference was widened to include not only members of the British plant breeding institutions but also representatives from the National Vegetable Research Station, Potato Genetics Station, East Malling and Long Ashton Research Stations, the Scottish Horticultural Research Institute, certain university departments and commercial seed firms. This enlargement resulted in a valuable exchange of ideas between research workers in different fields. The morning programmes were devoted to demonstrations of work carried out by the four departments of the John Innes Horticultural Institution. In all, there were thirty different demonstrations. The afternoon programmes consisted of papers followed by discussions. The papers were: "Breeding for Yield", by G. D. H. Bell and R. N. H. Whitehouse; "Variety Testing", by J. C. Haigh; "Reproduction of Stocks", by F. R. Horne; "Aids to Plant Breeding", by W. J. C. Lawrence; "Aims and Methods in Plant Breeding", by D. Lewis. A summary of each paper and a full account of the conference will appear in *Heredity*. The next conference is expected to be held at the Plant Breeding Division, Stormont, Northern Ireland, during July 6–7, 1954.

Brussels Conference on Ultrasonics

THE proceedings of the International Conference on Ultrasonics, held in Brussels during June 1951 (see *Nature*, 168, 106; 1951), have now been published in book form by the Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie (Brussels; 225 francs), under the auspices of which it took place. Thirty papers, divided into four sections, are covered in about three hundred pages: propagation in fluids; absorption in electrolytes and vibration potentials; propagation in liquid mixtures and suspensions; propagation in liquid helium. The conference thus dealt with the fundamental aspects of ultrasonics in fluids, in contrast to the international conference in Rome for the previous year, which was concerned mainly with applications in industry and medicine. Many of the papers in the first three sections at the Brussels conference were devoted to the theoretical or practical aspects of ultrasonic absorption considered as viscous or relaxation effects, and some discussion took place on the validity of the supposition that dilatational—as well as shear—viscosity plays a part in these phenomena. In the fourth section, there are a number of papers discussing the various theories which have been put forward to explain the existence of 'second sound' in liquid helium II.

Birmingham Symposium on Analytical Chemistry

FOLLOWING the International Congress on Analytical Chemistry in Oxford during September 4–9, the Midlands Society for Analytical Chemistry is arranging a symposium on analytical chemistry, to be held in the Chemistry Department of the University of Birmingham, during September 11–12. The main purpose of the symposium is to give those chemists in the Midlands who are unable to attend the Oxford Congress, the opportunity of hearing papers by, and meeting, analytical chemists of international repute. Prof. Fritz Feigl, of Rio de Janeiro, will be the honorary chairman. The programme on the first day will consist mainly of papers concerned with fundamental concepts of analytical chemistry, and the second day will be devoted to original methods. In addition, visitors will have the opportunity of seeing some of the research projects being carried out in the Research School of Analytical Chemistry at Birmingham, which is one of the largest and best equipped in Europe. The registration fee for non-members of the Society is 10*s*. and for members 5*s*. Further details can be obtained from the honorary secretary of the Society, W. T. Edwards, 100 Rymond Road, Birmingham 8.

International Institute of Welding: Meeting in Gothenburg

THE annual meeting of the International Institute of Welding will be held this year in Gothenburg during September 7–13. On the first day there will be a meeting of the governing Council of the Institute, and the following four days, September 8–11, will be devoted to meetings of the fifteen technical Commissions composed of representatives appointed by the societies belonging to the Institute. On the morning of September 12 visits will be made to shipyards and other works in Gothenburg, and in the afternoon four papers on "Welding in Shipbuilding" will be given by representatives of France, Great Britain, Sweden and the United States. The official programme will close with a further meeting of the governing council on September 13, after which those taking part will be free to join in a series of works visits in Stockholm, Malmö and other industrial centres, organized by the Swedish member societies of the Institute. Further information and enrolment forms can be obtained from Mr. G. Parsloe, Secretary-General, International Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

Museums and Education: Seminar in New York

A SEMINAR on "Museums and Education", organized by the United Nations Educational, Scientific and Cultural Organization, will be held in Brooklyn during September 14–October 12, under the directorship of Dr. Douglas A. Allan, director of the Royal

Scottish Museum, Edinburgh, with Dr. Hanna T. Rose, of the Brooklyn Museum, New York, as associate director. Senior officers will deal with individual subjects as follows: Dr. Torsten Althin (Tekniska Museet, Stockholm), science museums; Dr. J. Wijenbeek (Municipal Museum, The Hague), art museums; and Dr. F. T. de Souza (Ministry of Education, Rio de Janeiro), educational organization. Forty-five participants representing their respective countries in the United Nations will attend the seminar, together with fifteen expert observers, representing interested parallel or kindred organizations. There will be opportunities for inspecting museum and educational projects as far afield as Washington, D.C. The topics for discussion will include the following: subjects of education in various countries suitable for museum treatment, and the extension of school and college curricula to utilize museum resources for the training of museum and educational staffs for the work under consideration; the varied techniques required for different mental ages; contributions to the development of the handicapped; the initiation of fundamental education in underdeveloped countries; and the employment of the latest scientific inventions in the more advanced centres.

Lectures on Nuclear Reactors

A course of thirty lectures will be given in the City and Guilds College, University of London, during the 1952–53 session by members of the Atomic Energy Research Establishment (Ministry of Supply), Harwell. The first group of twelve lectures will be concerned with slow-neutron natural uranium reactors, concluding with a detailed description of the large pile at Harwell (BEPO). Another group of six lectures will deal with particular aspects of reactors of various types. Information will be given on the various possible systems, and the problems involved in metallurgy, chemistry, engineering, heat transfer and physics, will be discussed. One lecture on health physics will be included. A group of three specialized courses will include five lectures for mathematicians on more advanced slow- and fast-neutron theory; five lectures for engineers on heat transfer and reactor design; and a lecture for physicists on the experimental use of a reactor, followed by the opportunity to take part in experiments involving neutron diffusion and the measurement of a neutron flux. At the end of the course it is hoped to arrange a visit to inspect the Harwell piles and give an opportunity for informal discussion with the various lecturers. All the lectures are free to students of the City and Guilds College and London intercollegiate students; for others a fee of ten guineas, to be paid to the City and Guilds College, London, S.W.7, will be charged for the whole course, with reductions for those who wish to attend only a selected part.

British Institution of Radio Engineers: Awards for 1951

The British Institution of Radio Engineers has announced the following awards for 1951: *Clerk Maxwell Premium* (for the most outstanding paper published in the Institution's *Journal* during the year), to Dr. H. Paul Williams (formerly of A. C. Cossor, Ltd., and now with Fairey Aviation Co.) for his paper on "Subterranean Communication by Electric Waves"; *Heinrich Hertz Premium*, to R. E. Spencer (E.M.I. Engineering Development, Ltd.) for his paper on "The Detection of Pulse Signals near the Noise Threshold"; *Louis Sterling Premium*, to Emlyn Jones (Mullard Research Laboratory) for his paper on "Scanning and E.H.T. Circuits for Wide-Angle Picture Tubes"; *Leslie McMichael Premium*, to R. G. Kitchenn (formerly of the Local Lines and Wire Broadcasting Branch of the Engineer-in-Chief's Office, General Post Office) for his paper on "An 8-Channel Transmitter for an Experimental Carrier Wire-Broadcasting System"; *Brabazon Premium* (for the most outstanding contribution to the Institution's *Proceedings* on radio or electronic aids to aircraft safety), to G. E. Roberts (Decca Navigator Co., Ltd.) for his paper on "The Design and Development of the Decca Flight Log"; *Marconi Premium*, to E. G. Rowe (Brimar Valve Division, Standard Telephones and Cables, Ltd.) for his paper on "The Technique of Trustworthy Valves"; *President's Prize* (awarded to the most successful candidate in the Graduateship examination) and the *Electronic Measurements Prize* (awarded to the most outstanding candidate in Part IV, electronic measurements, of the Graduateship examination), to G. R. Beswick (Birmetals, Ltd., Quinton, Birmingham); *Mountbatten Medal* (awarded to the most successful candidate who passed the Graduateship examination while serving in the Armed Forces), to C. J. White (B.B.C., Daventry, and formerly of the R.A.F.).

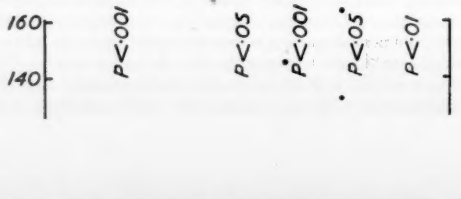
Announcements

Mr. William E. Miller has been nominated president-elect of the British Institution of Radio Engineers for 1952–53. Mr. Miller has been a member of the Institution for twenty years and was elected a vice-president in 1948, having previously been chairman of the General Council. He was one of the original signatories to the incorporation of the Institution in 1932.

The first of the Radio Industry Council's premiums of 25 guineas for technical writing, to be awarded to authors of technical articles deserving to be commended by the industry, has been won by Mr. J. R. Acton, of the Ericsson Research Laboratories, Nottingham, for his article on "The Single-Pulse Dekatron", published in the February issue of *Electronic Engineering*. The dekatron is a new type of gas-filled cold-cathode ray tube now being developed for use in scalers and computors.

Mr. T. E. Goldup, a director of Mullard, Ltd., has been appointed chairman of the Board of Governors of the Ministry of Supply School of Electronics, Malvern, in succession to Prof. Willis Jackson, professor of electrical engineering, Imperial College of Science and Technology, London. Mr. Goldup, who has had a wide experience of technical education in the electronics field, has been with the Mullard organization for more than twenty-nine years, and was formerly a member of the research staff of the Signal School, Portsmouth.

Erratum. In the communication entitled "Some Electrical Differences between Healthy and Virus-infected Potato Tubers", by C. G. Greenham *et al.*, which was published in *Nature* of June 7, p. 973, it is regretted that the top portion of the illustration is incorrect and should be as follows:



SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

IT is announced that, as in previous years, special posts have again been created to provide for the promotion in the Scientific Civil Service of individual research workers of exceptional merit. These promotions, which include for the first time one to the grade of chief scientific officer, are effective from July 1.

Chief Scientific Officer

MR. S. B. GATES has been at the Royal Aircraft Establishment, Ministry of Supply, since 1915, where he has acquired a reputation as one of the leading authorities in Great Britain on fundamental problems in aerodynamics. He has been particularly concerned with control problems, and the comparative ease with which the modern high-speed aircraft can be handled by the pilot owes much to his work.

Deputy Chief Scientific Officers

SIR DONALD BAILEY joined the Experimental Bridging Establishment, now the Military Engineering Experimental Establishment, Ministry of Supply, in 1929 and has been continuously working on design and development of bridging equipment for the Army. His most spectacular achievement is the bridge which bears his name, which has been found to have outstanding advantages in other fields of civil engineering.

DR. F. E. JONES joined the Telecommunications Research Establishment, Ministry of Supply, in 1940 and played a large part in the development of electronic circuits used in radar equipment for the R.A.F. He has also played a prominent part in the application of radar techniques to the study of weather and of weather forecasting.

DR. K. M. SMITH, director of the Plant Virus Research Unit, Cambridge, of the Agricultural Research Council, is a noted authority in the field of plant virus research. He has described many new virus diseases of horticultural and other plants and has investigated their transmission by insects and other means; he has studied the causal viruses by filtration and electron microscopy and, more recently, has greatly extended knowledge of the polyhedral diseases of insects. He is the author of a number of books on plant virus diseases.

DR. R. L. M. SYNGE, of the Rowett Research Institute, was jointly responsible with Dr. A. J. P. Martin for the early study and development of partition chromatography as an analytical procedure. He is also known for his structural studies on the nature of gramicidin, and, more recently, for his chemical studies of the nitrogenous compounds in green leaves and micro-organisms and the influence of degradation of protein in the rumen on its utilization by the ruminant animal. He is continuing to develop physicochemical techniques, such as electrophoretic ultra-filtration, for the analysis of substances of biochemical interest.

Senior Principal Scientific Officers

MR. G. BRADFIELD joined the National Physical Laboratory in 1949 to initiate work on ultrasonics after experience since 1923 in industry, the Air Ministry and the Telecommunications Research Establishment, Malvern. His earlier work was concerned mainly with the design and development of radio valves and centimetre radar, including responsibility for the design of complex war-time navigational devices. Since 1945 he has been engaged primarily in ultrasonic studies and is now a recognized authority on the subject. He is perhaps best known for the techniques developed for various purposes, such as flaw detection and the determination of elastic constants of crystals of isotropic and anisotropic solids over wide temperature ranges. In these fields the use of barium titanate as a novel piezoelectric material of high coupling has been explored and has yielded much improved devices.

DR. W. P. K. FINDLAY, who is officer in charge of the Mycology Section of the Forest Products Research Laboratory, is a graduate of the Imperial College of Science and Technology, London, where he was awarded the Edward Forbes Medal and a Remanet Fellowship. In 1925, on a Fellowship of the Empire Cotton Growing Corporation, he studied first at Cambridge and later in Trinidad. In 1927 he joined the Forest Products Research Laboratory and was associated with K. St. G. Cartwright at the beginning of the Laboratory's systematic investigation into fungal decay in timber. As a result the technique of recognition, in the absence of fructification, of the fungi responsible for various kinds of wood rot by growing them in cultures was developed and has led to the establishment of the Wood Destroying Fungi Section in the National Collection of Fungi. He has also undertaken the mycological aspects of comprehensive investigations into the influence of fungal infection on the mechanical properties of wood. Dr. Findlay has been joint honorary secretary of the Biological Council from its inception in 1945 and has also been president of the British Mycological Society.

MR. A. H. FORD-MOORE has served in the Chemical Defence Experimental Establishment of the Ministry of Supply since 1921. He has played a leading part in chemical research into methods of defence against chemical warfare. He is an outstanding experimentalist and well known for his work on the organic chemistry of sulphur and phosphorus.

DR. M. H. HEY, of the Department of Mineralogy, British Museum (Natural History), is a mineralogist and chemist of outstanding quality. His work on zeolites and his correlation of their properties with their crystal structure, and especially his study of the role of water in their constitution, was done between 1930 and 1937. He has specialized in inorganic microanalysis, and it is due to him that the chemical composition, and therefore the crystal structure and content of the unit cells of many new minerals, have been established. In addition to his chemico-mineralogical work, Dr. Hey has charge of the great collection of meteorites in the Natural History Museum; in this work he has contributed many analyses of new meteorites and has just completed a new catalogue of the collection. He is the author of "An Index of Mineral Species and Varieties arranged Chemically".

MR. W. R. LANE joined the Chemical Defence Experimental Establishment of the Ministry of Supply

in 1929. His work has been mainly concerned with the physics of chemical defence problems, in which field his fundamental studies on the mechanism of the break-up of liquid drops and the formation of aerosols has contributed materially to present-day knowledge. His ingenious microburette for accurately delivering small drops of known size has now become a well-known instrument which is used in laboratories all over the world.

Dr. J. G. Nagelschmidt, of the Safety in Mines Research Establishment, is a mineralogist of international reputation and is now engaged on research into the mineralogical aspects of pneumoconiosis. He has been a pioneer in the application of X-ray diffraction techniques to the study of clay materials, in the application of new mineralogical techniques to the study of dusts responsible for lung disease, and in the application of the electron microscope to the study of clay minerals and dusts. He has developed and is still developing new techniques for the quantitative mineralogical analysis of small dust samples and for the identification of particular mineral particles too small for identification with the optical microscope. He is a member of the Industrial Pulmonary Diseases' Committee of the Medical Research Council and is secretary of the Sub-Committee on Dust.

Dr. H. H. M. Pike joined the staff of the Research Department, Woolwich, now under the Ministry of Supply, in 1932, his early work being concerned with the internal ballistics of guns. More recently he has turned his attention to the study of the phenomena occurring during the detonation of high explosives, and his findings are the basis of civil defence teaching in connexion with the effects of blast on buildings.

Mr. J. S. Preston has been at the National Physical Laboratory for the past twenty-five years and was at first concerned with the development of photometric and radiometric methods of measurement. Through his work a standard design for commercially produced photo-emissive cells for precision photometry has been adopted. Later his attention was attracted to selenium cells, and he undertook investigations into their use in physical photometry; but the wide divergence between the theory and their practical behaviour led to a detailed investigation into the fundamentals of the constitution of rectifying contacts. This in turn was followed by work on the deposition and properties of a wide variety of thin films, and in this connexion the most recent development is the discovery of the technique necessary for the deposition on glass of a transparent electrically conducting metallic film of low resistance; this will have considerable practical value, as an electric current passing through the film will generate sufficient heat to prevent the deposition of moisture. Mr. Preston was the general secretary of the International Commission on Illumination during 1932–49.

Dr. J. Thomlinson joined the Royal Aircraft Establishment, Ministry of Supply, in 1939, where his work has been directed to the problems connected with the landing and take-off of aircraft from ships at sea and from confined spaces on land. He carried out the first known fundamental investigation into the performance of arrester gears used in deck landings of aircraft, and he originated and has since been responsible for the development of the flexible deck system for landing high-speed aircraft.

Mr. C. K. Thornhill entered the Ministry of Supply in 1940 and has been attached to the Armament Research Establishment since 1943. Throughout this period he has worked with conspicuous success on mathematical problems connected with guns and explosions. His contributions to the field of gun erosion were recognized by the United States Government in 1947 by the award of the American Medal of Freedom.

Mr. J. H. Whitaker, who joined the Royal Aircraft Establishment, Ministry of Supply, in 1936, is a mechanical engineer and has made valuable contributions in many fields. He became a recognized authority on aircraft fuel and oil systems during the Second World War and has since been responsible for the development of essential components for guided missiles.

PHYSICAL SOCIETY

ANNUAL GENERAL MEETING

At the annual general meeting of the Physical Society, held at the Royal Institution on May 20, the reports of the Council and of the honorary treasurer and the accounts and balance sheet for 1951 were presented and adopted. The officers and Council for 1952–53 were elected (see *Nature*, June 14, p. 995). At the extraordinary general meeting held immediately prior to the annual general meeting, Profs. Otto Hahn and M. T. von Laue were elected to honorary fellowship of the Society, and certain changes in the articles of association of the Society, which would make the procedure of election of officers and Council more democratic, were agreed to be submitted to the Board of Trade for approval.

During 1951, the Council reports, the membership rose to 2,025 and the activities of the Society again increased. It is gratifying to note that the decline in recent years in the number of newly elected Fellows has been arrested and that there have been substantial increases in both the studentship and fellowship grades. The work of the Society has been considerably hampered by rising costs of publication and shortage of paper, and the Council has given earnest consideration to the possibility of effecting economies and increasing efficiency. A scheme for introducing a reduced basic subscription for membership of the Society, with separate payment for all publications, has received considerable support and it is likely that some such scheme will be adopted for operation in 1953. Closer collaboration has been effected between the Society and the Institute of Physics, and members now receive notice of meetings of the Institute, which they are invited to attend. They may also obtain one of the Institute's two journals at a reduced subscription-rate.

In addition to nine science meetings held in London during the year, a two-day meeting was held at University College, Southampton, and three-day meetings at University College, Swansea, and at the Queen's University, Belfast. In April a conversazione for members and their friends was held in the rooms of the Royal Society and the Royal Geographical Society. The seventeenth Thomas Young Oration was delivered by Prof. W. D. Wright, who spoke on modern problems in colorimetry; the thirty-fifth Guthrie Lecture by Prof. N. F. Mott, on the mechanical properties of solids; and the 1951 Parsons Memorial Lecture by Mr. F. Twyman, on Sir Charles Parsons and optical engineering. Sir Thomas Merton

was the recipient of the sixth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place on May 15 at the Salons de l'Université à la Sorbonne, Paris, when Sir Thomas delivered the Holweck Discourse on the subject of new methods of making diffraction gratings. Sir George Simpson received the sixth Charles Chree Medal and for his address gave reminiscences of fifty years work in geomagnetism and geophysics. The twenty-eighth Duddell Medal was presented to Dr. A. B. Wood, who gave an account of his work on underwater acoustics, and the seventh Charles Vernon Boys Prize to Dr. J. H. E. Griffiths, who discussed ferro-magnetic resonance.

Details of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustics Groups, together with a list of the numerous bodies on which the Society is represented, are given in the annual report. In addition to science meetings, the Low Temperature Group held two major conferences—the Oxford Conference on Low Temperatures, and the Eighth International Congress of Refrigeration, in London. The Acoustics Group took an active part in the establishment of *Acustica*, and also in the general arrangements of the Acoustics Division of the Building Research Congress held in London during September.

The honorary treasurer again directs attention to the dependence of the financial structure of the Society on the success of the annual exhibition, which, although it had a record attendance and was of high standard, nevertheless resulted in a much smaller financial benefit to the Society than in the previous year. Thus the Society only just paid its way during 1951, and the future outlook depends very largely on the extent to which costs continue to rise. However, with the continued support of its members and with the suggested modifications in the form of subscriptions, it is hoped that the financial position of the Society may be made secure without curtailment of publications or activities.

MARINE BIOLOGY IN SCOTLAND

REPORT FOR 1950–51

THE annual report and collected reprints (Nos. 57–87) of the Scottish Marine Biological Association for the year 1950–51* have recently been published. A study of this volume leaves no doubt that the Association's Millport Laboratory is working most successfully and at very high pressure. The scientific staff now numbers nine (excluding the Director), and their researches cover many fields, including plankton investigations, a re-survey of the fauna of the Clyde Sea Area, the life-history of barnacles, the factors governing barnacle settlement and their relationship with those governing other settling organisms, the operation of fishing trawls, oyster culture and marine algology. Of special interest and importance is the initiation of experiments in underwater television, for which a special grant has been obtained from the development fund of the Association. A new device for measuring the depth at which gear is working in the sea is also being developed. Already this apparatus can be used to a depth of 200 m. with an accuracy of ± 2 per cent in continuous readings on deck.

* Scottish Marine Biological Association. Collected Reprints, 1951: Nos. 57–87. (Millport: Marine Station, 1952.)

To improve facilities at the Station, a new two-story building with a reinforced concrete seawater storage tank on its roof is being built. The masonry of some extra research rooms, and a new workshop and store are mainly completed. Reconstruction of the aquarium is about to be put in hand. Certain administrative changes have also been made by which the Director of the Station acts also as Secretary to the Council—an arrangement that should bring about increased efficiency and smoother running of the whole establishment.

The Oceanographical Laboratory at Leith now comes under the administration of the Association, a special sub-committee of which has been nominated to advise on matters of scientific policy. The programme of research follows two main lines—plankton recorder surveys and investigations into the relationship between the herring and its environment during the Scottish summer fishery at Fraserburgh. During the year some thirty thousand miles of recorder sampling was carried out, the analysis of which must alone be a huge undertaking.

Until lately the Leith laboratory was administered by Hull University College and its reports published as *Hull Bulletins of Marine Ecology*. It is intended to continue their publication in the same format but under a suitably modified title such as *Bulletins of Marine Ecology*.

The Laboratory's present accommodation at Leith and Edinburgh is unsatisfactory and inadequate; but negotiations are now proceeding for the purchase of a property in Edinburgh which, when converted and equipped, will be more suitable.

COLONIAL DEVELOPMENT AND WELFARE

DETAILS OF SCHEMES FOR THE YEAR 1951–52

THE schemes detailed in the latest return made under the Colonial Development and Welfare Acts, covering the period April 1, 1951–March 31, 1952*, bring the total commitments for development and welfare schemes under the Acts to £83,983,947, of which £16,038,184 is for the year in question, and for research schemes to £10,745,100, of which £868,851 is for the year ended March 31, 1952. Of this, £373,826 is for agriculture, £136,803 for medicine, £109,804 for social science, £70,575 for tsetse and trypanosomiasis research, £42,778 for insecticides research, £42,045 for fisheries research, £38,050 for locust control and £9,100 for products research. There are no grants for research fellowships, and only £1,420 for economic research.

Of the actual research schemes, the largest are £97,220 for the establishment of the West African Institute of Social and Economic Research, covering capital and recurrent expenditure during July 1, 1951–March 31, 1956, £70,600 as supplementary provision for four and a half years for the establishment of a West African Rice Research Station at Rokupr, Sierra Leone, and £95,000 for the establishment of a Veterinary Research Laboratory and ancillary facilities in the Federation of Malaya. Pilot

* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies with the Concurrence of the Treasury in the period from 1st April, 1951, to 31st March, 1952. (Cmd. 211.) Pp. 44. (London: H.M.S.O., 1952.) 1s. 6d. net.

schemes for the reclamation of tsetse-infested land in Kenya, Uganda and Tanganyika are allotted £70,000 over four years, and £38,000 over four and a half years is granted for the establishment of a Fisheries Research Unit at the University of Hong Kong. Other grants include £34,500, also over four and a half years, for research into the incidence of maize rust in West Africa, £31,500 (over the period January 1, 1952–March 31, 1956) for physiological and biochemical research at Makerere College, Uganda, £34,000 for the establishment of a training centre for ecologists selected for work in Colonial territories, £28,750 for the Anti-Locust Research Centre, and a supplementary £26,620 for the East African Agriculture and Forestry Research Organization for the year ending December 31, 1952.

The only other grants exceeding £20,000 are: £25,000 for hiring and equipping aircraft for disseminating insecticides in East Africa, £23,000 for further research over four and a half years by Dr. C. A. Walton into relapsing fever in East Africa, £24,403 (supplementary) for the Nutrition Field Station, Fajara, Gambia, £22,083 over four years for re-establishment of the Herbarium at Sandakan, North Borneo, and appointment of a botanist, and £21,000 over three years for the Ecological Land Use Survey, British Honduras. Reference should also be made to the grants of £19,300 for investigation, over five years, of seismic activity in the Windward and Leeward Islands, £17,500 to extend clove research at Zanzibar until August 31, 1953, £15,400 for experiments in East Africa on the dissemination of insecticides from fixed-wing aircraft, and £14,000 for the establishment of a Colonial pool of plant pathologists at the Commonwealth Mycological Institute.

Grants of particular scientific interest for development and welfare schemes, apart from those for scholarship training schemes and the like, include £31,000 for the establishment of an Applied Nutrition Unit at the London School of Hygiene and Tropical Medicine, £150,000 for a Technical College at Nairobi, a further £202,500 for Makerere College, £130,000 for tsetse and trypanosomiasis reclamation in East Africa, £55,300 for the Geological Survey of Somaliland Protectorate, £21,911 for a survey of timber resources in Northern Rhodesia, £9,283 for the extension of the Government Veterinary Research Station, Mazabuka, £52,500 for the Geological Surveys Department of Nyasaland, and £150,000 for the comprehensive survey of the Shire Valley project. A further grant of £52,234 is to University College, Ibadan, Nigeria, and £87,700 for the development of medical and health services in Gambia, while of £6,784,700 for the revised Ten-Year Development Plan for Nigeria, £1,049,832 is for agriculture, £853,053 for technical education, £154,674 for forestry, £395,899 for leprosy control, £1,587,861 for medical and health, and £223,261 for veterinary services. £43,163 is granted for animal husbandry in Sierra Leone, £30,000 for agricultural development in Basutoland, £51,474 for anti-malarial works in Mauritius, £200,000 to the University of Hong Kong, £42,706 for meteorological services in South-East Asia, £55,000 for the Eastern Caribbean Farm Institute, £58,337 for meteorological services in the West Indies, £25,867 for cocoa development in British Guiana, and various sums totalling £311,050 to the University College of the West Indies and its teaching hospital. Grants for road development schemes, rural water supplies, the establishment of local broadcasting services and the like figure prominently among the remainder.

REACTIONS OF PHENYL RADICALS IN SOLUTION AND IN THE GASEOUS PHASE

By M. T. JAQUISS and Dr. M. SZWARC
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THE reactions of phenyl radicals in solution have been extensively investigated by many workers. A comprehensive summary of these studies has been presented in a monograph by Waters[1]. It appears that phenyl radicals react differently with aliphatic and with aromatic solvents. With the former they seem to undergo an atom transfer reaction; for example:

$$n\text{-}C_6H_{14} + Ph\cdot \rightarrow C_6H_{15}\cdot + Ph.H.$$
$$CCl_4 + Ph\cdot \rightarrow CCl_3\cdot + Ph.Cl,$$

while the reactions with aromatic solvents lead to the formation of substitution products. Waters[2] interpreted the course of this substitution reaction by the equation

$$Ph\cdot + C_6H_5X \rightarrow Ph.C_6H_4.X + H. \qquad (1)$$

It is particularly interesting to note that the reaction of phenyl radicals with toluene leads to the formation of the isomeric methyl-diphenyls $CH_3.C_6H_4.C_6H_5$, and that dibenzyl was never detected among the products of the reaction[3]. This observation seems to exclude the alternative interpretation of the reaction, namely,

$$Ph\cdot + C_6H_5.CH_3 \rightarrow Ph.H + \cdot C_6H_4.CH_3 \qquad (2)$$
$$Ph\cdot + \cdot C_6H_4.CH_3 \rightarrow Ph.C_6H_4.CH_3, \qquad (3)$$

since the inequality:

$$C_6H_5.CH_2\text{—H dissociation energy} < CH_3.C_6H_4\text{—H dissociation energy}$$

requires that phenyl radicals should abstract preferentially the hydrogen atom from the methyl group rather than from the benzene ring. Such a reaction, however, would lead to the formation of benzyl radicals:

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H, \qquad (4)$$

and thus dibenzyl or diphenyl-methane would be expected as products of the reactions, contrary to the observations.

This peculiar behaviour of phenyl radicals induced us to investigate their reactions in the gaseous phase. Several sources of phenyl radicals were explored by using pyrolytic methods. We found that iodo-benzene, bromo-benzene, mercury-diphenyl, benzyl-benzoate, benzoyl-bromide and benzil generate phenyl radicals in our experimental arrangement, whereas benzo-phenone and azo-benzene required for their decomposition temperatures higher than our experimental conditions permitted. All experiments were carried out in a flow system, described in previous communications[4], the total pressure being of the order 10–20 mm. mercury, and the time of contact of the order of half a second.

Iodo-benzene decomposes rapidly at temperatures of about 600° C. The decomposition is complicated by the presence of iodine atoms and molecules, and therefore is not suitable for studying the reactions of phenyl radicals. Neither is it convenient to use

bromo-benzene as a source of phenyl radicals, since the decomposition requires rather high temperatures (800–900° C.) and consequently is complicated by the considerable amount of products formed by the decomposition of toluene used as a carrier gas.

The decomposition of benzyl-benzoate (studied in our laboratories by Mr. J. W. Taylor) seems to take place according to the expression :

$$Ph.CO.O.CH_2.Ph \rightarrow Ph.CO_2 + Ph.CH_2\cdot, \quad (5)$$

followed by the rapid reaction

$$Ph.CO_2 \rightarrow Ph\cdot + CO_2.$$

In the presence of toluene, phenyl radicals react according to (4), producing benzyl radicals :

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H, \quad (4)$$

and the dimerization of the latter yields dibenzyl. The experimental results are given in Table 1, which shows that two benzyl radicals, that is, one molecule of dibenzyl, are produced for each molecule of benzyl-benzoate decomposed (or for each molecule of carbon dioxide formed in the pyrolysis). The initial decomposition (5) accounts for half the amount of dibenzyl collected, whereas the second portion is undoubtedly produced by reaction (4).

TABLE 1. DIBENZYL SEPARATED FROM BENZYLBENZOATE BY CHROMATOGRAPHIC TECHNIQUE

T °C.	Carbon dioxide (m.mol.)	Dibenzyl (m.mol.)	Ratio of dibenzyl to carbon dioxide
674	0·448	0·407	0·91
666	0·322	0·312	0·97
704	0·481	0·482	1·00
698	0·404	0·389	0·96
691	0·323	0·321	0·99
687	0·293	0·339	1·16 (?)
699	0·430	0·428	1·00
700	0·399	0·425	1·06
697	0·423	0·404	0·95

m.p. 51° C. after a gentle pressing on a porous tile

The decomposition of benzoyl bromide, investigated by Ladacki, Leigh and Szwarc[5], appears to be a clean-cut reaction proceeding according to the following mechanism :

$$Ph.CO.Br \rightarrow Ph.CO + Br,$$

followed by the rapid reaction

$$Ph.CO \rightarrow Ph\cdot + CO.$$

Under conditions prevailing in our experiments, bromine atoms react with toluene yielding hydrogen bromide and benzyl radicals[5] :

$$C_6H_5.CH_3 + Br \rightarrow C_6H_5.CH_2\cdot + HBr. \quad (6)$$

However, the amount of dibenzyl collected in the pyrolysis of benzoyl bromide exceeds that anticipated on the basis of reaction (6) only (see Table 2), and this observation indicates that phenyl radicals reacting with toluene produce benzyl radicals. Moreover, benzene was detected among the products of the decomposition, and this proves definitely that reaction (4) takes place (we are indebted to Anglo-Iranian Oil Co. for their help in analysing toluene for its benzene content).

Pyrolysis of benzil appears to be the most convenient source of phenyl radicals. The reaction takes place according to the expression :

$$Ph.CO.CO.Ph \rightarrow 2Ph.CO,$$

TABLE 2

T °C.	Carbon monoxide (m.mol.)	Dibenzyl (m.mol.)	Melting point	Ratio of dibenzyl to carbon monoxide
662	1·44	1·15	50–51° C.	0·80
662	1·05	0·84	50–51° C.	0·80
617	0·65	0·49	51–52° C.	0·75
638	1·58	1·20	48–50° C.	0·76
657	1·20	0·97	49–50° C.	0·81

followed by the rapid reaction

$$Ph.CO \rightarrow Ph\cdot + CO.$$

Thus, the rate of formation of phenyl radicals can be measured conveniently by the rate of formation of carbon monoxide. The investigation is simplified by the fact that phenyl radicals are the only reactive species produced initially in the system. Dibenzyl was the only non-volatile product produced in the pyrolysis taking place in the presence of toluene, which proves beyond any doubt that phenyl radicals react with toluene according to (4).

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H. \quad (4)$$

The experimental results are given in Table 3. The melting points of the non-volatile products collected indicate that they contain more than 95 per cent of dibenzyl (in this connexion see also Tables 1 and 2). It has been shown that a mixture containing 95 per cent of dibenzyl and 5 per cent of diphenyl melts at 46–47° C.

TABLE 3

T °C.	Carbon monoxide (m.mol.)	Dibenzyl (m.mol.)	Melting point	Ratio of dibenzyl to ½ carbon monoxide
603	2×0·336	0·324	48–50° C.	0·965
593	„ 0·434	0·417	49–51° C.	0·96
600	„ 0·654	0·626	49–51° C.	0·96
723	„ 0·598	0·560	48–50° C.*	0·94

* After gentle pressing on porous tile

We conclude, therefore, that phenyl radicals reacting with toluene in gaseous phase and at high temperatures abstract hydrogen atoms from methyl groups. On the other hand, the reaction in solution and at room temperature leads to their addition to benzene ring. We suggest tentatively the following explanation for the divergence of the behaviour of phenyl radicals. Phenyl radicals, having one hydrogen atom removed from the ring, might approach sufficiently close to the nucleus of an aromatic compound for a relatively strong π—π bond to be formed. To appreciate the strength of such a bond, let us compare $D(CH_3—CH_3)$ with $D(C_6H_5—C_6H_5)$. The C—C dissociation energy of the former is 83 kcal./mole, while we estimate the magnitude of the latter at about 97 kcal./mole. (Investigation of the pyrolysis of bromo-benzene carried out in our laboratories by Mr. D. Williams leads to $D(C_6H_5—Br) \sim 71$ kcal./mole. This value, in conjunction with the relevant thermochemical data, leads to $D(C_6H_5—H) \sim 102$ kcal./mole and $D(C_6H_5—C_6H_5) \sim 99$ kcal./mole.) This remarkable increase in the C—C dissociation energy probably measures the strength of the π—π bond in diphenyl[6]. The formation of a π—π bond between a phenyl radical and an aromatic compound leads to a 'hot' complex which contains all the energy of the interaction. Such a 'hot' complex is certainly unstable at

the high temperatures and low pressures prevailing in our experiments, and thus it decomposes rapidly. On the other hand, in solution and at room temperatures the excess of energy might be removed by collisions with molecules of solvent, and thus the stabilized complex might survive until a collision with another phenyl radical would lead to the abstraction of hydrogen atom and completion of the reaction.

The fact that the addition reaction prevails at room temperature indicates that its activation energy is probably lower than that of the hydrogen abstraction reaction. Indeed, the analogy with the corresponding reaction of methyl radicals[7] might suggest an activation energy of the order of 8 kcal./mole for reaction (4). [March 20.

[1] Waters, W. A., "The Chemistry of Free Radicals" (Oxf. Univ. Press, 1948).
[2] Waters, W. A., see ref. 1, p. 147 and p. 149.
[3] Hey, D. H., *et al.*, *Research*, 4, 386 (1951).
[4] Szwarc, M., *J. Chem. Phys.*, **17**, 431 (1949); *Proc. Roy. Soc.*, A, **198**, 267 (1949).
[5] Ladacki, M., Leigh, C. H., and Szwarc, M., *Proc. Roy. Soc.* (In the press).
[6] Szwarc, M., *Nature*, **161**, 890 (1948).
[7] Trotman-Dickenson, A. D., and Steacie, E. W. R., *J. Chem. Phys.*, **19**, 1097 (1951); see also *J. Amer. Chem. Soc.*, **72**, 2310 (1950).
[8] Szwarc, M., Ghosh, N. B., and Sehon, A. H., *J. Chem. Phys.*, **18**, 1142 (1950).

ARCTIC AEROBIOLOGY

FUNGI AND BACTERIA, ETC., CAUGHT IN THE AIR DURING FLIGHTS OVER THE GEOGRAPHICAL NORTH POLE

By Prof. NICHOLAS POLUNIN* and Dr. C. D. KELLY

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WHEREAS previous contributions[1] have been concerned with material gathered by Polunin while flying over northern Canada in 1947, the present communication reports upon the result of subsequent flights from central Alaska to the North Pole and back which he made in the following years—in the last instance accompanied by Kelly and S. M. Pady. In the meantime, the work had been adopted as an extra-mural research project by the Defence Research Board of Canada, and it is a pleasure to express gratitude for the all-important governmental assistance in Canada and the United States which has thus been obtained and co-ordinated. These flights were special ones in United States Air Force B-29 (Superfortress) aircraft of the 72nd (Very Long Range) Reconnaissance Squadron operating out of Ladd A.F. Base, Fairbanks, Alaska, and in this connexion our warm thanks are due to the late General Dale V. Gaffney, Colonel Neil D. van Sickle, and Lieut.-Col. Charles F. Overstreet, for the unique facilities afforded and the splendid co-operation of all their officers and men concerned. Thanks and appreciation are also due to the Royal Canadian Air Force for much incidental transportation and hospitality, and to the Defence Research Board in general and Lieut.-Col. G. W. Rowley and Mr. C. P. McNamara of the Arctic Research Section in particular, for their efficient handling of many problems involved. Without such support and the co-operation of many other bodies and individuals, in Washington and Ottawa, Montreal and Alaska, the chance to do this work could scarcely have materialized. There were also the pilots on those long (and in the first case arduous) flights, and the five or six busy navigators and radar observers who made up such a large proportion of the picked and trained crews of fifteen or sixteen—not to mention the almost equally essential ground-staffs of many and various categories, among whom were Major Joseph J. Slack (O.C. Base Weather Detachment), Captain Vaughan (operations officer), the Engineering and Intelligence personnel, and Colonel R. R. Stewart (base supply officer).

The first of his polar flights was made by Polunin on September 13–14, 1948. Planning had extended over much of the previous year, with the design and construction of special apparatus for the purpose, and been backed by active work at laboratory techniques by Pady and Kelly[2]. The apparatus, which it is hoped to describe and figure in more detail elsewhere[3], was required for exposure of Petri plates vertically against the unobstructed airstream in front of an aircraft travelling at high speed, with low temperatures outside and possible pressurization inside. Essentially it consisted of a steel plate replacing the front large 'Plexiglas' window in the nose, into which a short piece of steel tube was welded in a horizontal position so as to act as a sleeve and lead to an opening in the plate that could be closed by a metal sliding door. A second steel tube, 68 cm. long and blocked off with a handle at the back, was made to slide within the sleeve; its inside diameter was such that it would just take a standard (10 cm. diameter) Petri dish which rested against a blocking-off metal plate just behind the front end of this inner tube or cylinder and was held in place by lateral steel clips. In the sleeve was cut a loading-breech with an airtight cover to allow changing of the Petri dishes when the inner tube was withdrawn and the sliding door closed. Loading was accomplished by pressing a sterile, unwrapped, but still covered, Petri 'plate' into position and then removing the cover, after which the breech was quickly closed, the sliding door opened, and the inner tube slid forward and locked in the exposing position in which the Petri plate was held flat against the airstream well ahead of anything else on the plane. In connexion with the construction of this apparatus special thanks are due to Prof. J. S. Foster, of McGill University.

The sticky surface for 'catching' was a thin smear of silicone grease (DC-4-ANC-128-A) on the inside of the base of the Petri dish; this particular grease retains its stickiness through the remarkable temperature-range of -75° C. to more than 200° C. and appears to be neutral to most biological activity. Expert mathematical advice had indicated that we might expect at least 40 per cent of the particles in the atmosphere to penetrate any air-cushion—for example, that might be built up in front of the Petri plate which was already far enough ahead of the nose to avoid its air-cushion—and consequently become stuck on the silicone surface during flight.

Practically throughout the first polar flight and a training and testing preliminary, plates were loaded and exposed for periods of up to ten minutes. Then, on return to the laboratory, the silicone surface was 'poured' with melted agar for observation of the fungi and bacteria the growth and development of which were able to proceed when the nutrient covered the surface to which they had become attached. It

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had been established that in such circumstances members of both groups can produce satisfactory colonies[2], the results of such growing and subsequent sub-culturing for determination being indicated in the present instance in a table[4]. It should be noted that throughout this article the 'bacterial' colonies are apt to include very occasional (usually single) ones of non-filamentous yeasts which have a very similar appearance. No Actinomycete was found.

Whereas the counts are low and indeed often within the bounds of possible contamination, their grouping and the working of the controls give confidence in their general validity. Thus plates that were exposed on a wooden post 50 ft. up on a hangar at Ladd A.F. Base throughout the 17 hr. 25 min. of the polar flight gave 100 bacterial and 78 fungal colonies in the case of an agar plate and 350 bacterial and 72 fungal (of which 60 were filamentous yeasts) in the case of a silicone plate which had flies sticking to it. Plates exposed for an hour each in the nose of the aeroplane very early in the polar flight gave 13 bacterial and 9 fungal colonies in the case of an agar plate and 20 bacterial and no fungal colonies in the case of a silicone one; similar exposures for three hours much later in the flight gave 13 bacterial and 2 fungal colonies in the case of an agar plate and 13 bacterial and no fungal colonies in the case of a silicone one—which suggests that the air in the 'plane was not at all heavily loaded and that the silicone smear afforded, at least for bacteria, a not less effective method of catching and observing by subsequent growth than did the very 'general' nutrient agar employed. More important were the loading, etc., controls performed very early in, and repeated towards the end of, the polar flight. Each consisted of three 'exposures' of silicone plates, namely: (*a*) a normal loading, uncovering, re-covering, and removing of the plate in the breech without moving the sliding inner tube, (*b*) the same operation with, before re-covering and removal of the plate, a normal sliding of the tube momentarily up to and back from the unopened front door, and (*c*) the same as (*b*) except for an opening of the door and further sliding forward of the inner tube so that the Petri plate was exposed for 2–3 sec. just in front of the forwardmost part of the steel plate before retraction, closing of the door, and re-covering and unloading. Just after take-off for the Pole, (*a*) and (*b*) were blank but (*c*) gave 22 bacterial and 3 fungal colonies; much later, on the homeward flight, (*a*) was blank, (*b*) gave only a single bacterial colony, and (*c*) was blank. The only seriously disconcerting feature about these controls is the reading given by (*c*) after take-off, which suggests dire need for that scouring of the forward fixed part of the apparatus which was soon to be accomplished. It may be expected to have been effected by the time the real exposures were started many minutes later, although an outlet of contaminated air due to pressurization may have complicated this issue.

The main conclusion to be drawn from the results of this very fortuitous sampling as indicated in the table[4] is that, although the air above and around the North Pole may tend to be practically sterile, it is by no means entirely so. Thus a few bacteria and very occasional yeasts appear to have been present in a viable condition on this occasion, especially at or slightly above 8,500 ft. in the vicinity of the Pole itself. There also appeared to be a slight bacterial 'peak' not far north of Point Barrow; but unfortunately, owing to pressurization difficulties, no readings could be taken in this region on the return journey. The relatively high bacterial counts obtained from the earliest exposures made over central Alaska were not borne out by those made farthest south on the return flight, although there is still a significant increase of colonies here (7 on 5 plates exposed for a total of 22 minutes) over the counts made most recently though at the higher altitude of around 18,500 ft. farther north (3 on 9 plates exposed for a total of 31 minutes). The speedy turnover of plates was effected largely to give fresh surfaces, because many rapidly became iced and it was not then realized that 'catching' could nevertheless in all probability still proceed, as supercooled water droplets occur rather than ice crystals in clean air down to −41° C.[5].

Through the kind co-operation of meteorological and monitoring services, we are familiar with the probable sources of the air-masses in which the plates were exposed, on both the northward and homeward-bound flights. There is some suggestion of correlation between the air-mass sources and the biota observed, even if the readings are apt to be patchy. Thus, whereas northward to around 77° N. the exposures were made in air of relatively southern and favourable origin (in which 19 totalling 80 minutes showed 157 colonies in spite of an almost blank 'run' near the middle), north of here the air-mass was of less favourable (northern and largely frozen-up) source, and the next five exposures totalling 24 minutes showed only 2 colonies. The rise thereafter is not accounted for by the computed air-mass sources but may well be due to an extension southward to nearly the 80th parallel in the meridians of the 'pole of inaccessibility' of the very mixed air which tends to circulate around the geographical North Pole, and which on this occasion appears to have had, in part at least, a less unfavourable origin in the Canadian Arctic Archipelago. Thus we have a run of 12 exposures totalling 44 minutes bearing 76 colonies and extending to the actual Pole, followed by 21 totalling 49 minutes and bearing only 18 colonies—quite possibly because, with the exception of the first two which were lower (a 2-minute exposure at 3,000 ft. as the Pole was circled proved entirely blank), they were all exposed at much higher altitudes of mostly more than 18,000 feet. Around 25,000 feet above sea-level over the vicinity of the North Pole, the atmosphere appeared to be entirely sterile. It is quite conceivable that the very low temperatures (at least down to − 48° C.) encountered at these higher latitudes and altitudes may have accounted for a lack of viability in some instances, but it is not now thought that the abiotic radiation effect, if any, is here as great as in temperate regions. Meanwhile it must be emphasized that only the most tentative conclusions should be drawn from these results, which are of a mere preliminary and largely qualitative nature.

The second aerobiological flight over the North Pole took place in March 1949, the object being to carry further such observations as had been made on the previous occasion and to compare winter with more-or-less æstival conditions, while hoping to make a flight under full summer conditions at some later date. Meanwhile Kelly and Pady, particularly, had worked at the apparatus and techniques so that this time it was possible to have the following three systems in operation all together: (1) the qualitative 'artificial hand' for exposing Petri plates in front of the nose of the aircraft as used on the previous

occasion, except that, instead of the general silicone smear, two similarly smeared microscope slides which could be removed for separate treatment and examination were stuck with drops of rubber cement side by side on the inside of the bottom of each plate; (2) a General Electric "Electrostatic Bacterial Air-sampler" taking sterile Petri plates and installed in a glass-faced aluminium box connected with the outside atmosphere by 1-in. bore rubber tubes leading from the nose and so arranged, with the inlet pointing forward and the outlet turned aft, as to create a 'Venturi' effect causing a gentle flow of air through the box; and (3) a filter of glass-wool and lens-paper packed in a brass hose coupling of 1-in. inside diameter, similarly connected (in the outlet through a flow-meter) with the outside air by 1-in. hosing. The sampler employs an electrostatic field of some 6,500–7,000 volts and takes two Petri plates at a time, one having its base positively charged and the other negatively, the biota and other particles being precipitated on to their inside surfaces; a constant volume of one cubic foot of air a minute is sampled by being blown over the sterile surface, either a silicone smear or agar medium being used in the dishes. Each filter is made of four disks of glass-wool, each disk being of four thicknesses of the 'wool' as it comes from a fresh roll, cut with a 1½-in. cork-borer and enclosed by lens-paper disks to prevent shearing and to hold the spicules in, this 'stack' being placed in the detachable hose coupling the ends of which are plugged with cotton-wool and then covered with parchment paper caps for sterilization and finally storing after wrapping in a clean paper towel for protection against dirt.[3]

The experience of the previous polar flight had suggested that the air might be virtually sterile, as had winter work by Kelly and Pady over the prairies; on the other hand, we now supposed that catching could proceed even under bad icing conditions; so instead of a large number of short exposures we decided to make most of them last a full hour. On return to the laboratory one of each pair of the nose-exposed slides was microscopically examined for fungi and the other for pollen grains, the area perused in each case being that of a 22 × 50 mm. cover-slip and the mount employed in the latter case being glycerine jelly containing basic fuchsin; the silicone-smeared plates from the electrostatic sampler were 'poured' with agar and the agar ones incubated directly; the glass-wool and lens-paper filter plug was removed with sterile forceps from each coupling and shaken vigorously for ten minutes with 50 c.c. of sterile water, 5-c.c. and 2-c.c. portions being then placed in Petri dishes and melted agar added before incubation at 25° C. and counting after five days.

The results of an abortive mission on March 28 and of a successful polar flight on March 29 and 30 are indicated in another table[4]. All apparatus was well scoured by air before use, the controls and briefer exposures including various loading and other controls of the nature of those practised on the previous occasion with the artificial hand. These were entirely blank as regards pollen grains or allied spores, as were unexposed slides and several exposed for periods of up to seven minutes at various stages of both the 1949 flights, with the exception of a 7-min. exposure made as we were turning in the immediate vicinity of the North Pole, which had on one slide a ragweed or closely allied pollen grain and a smut or allied fungal spore and, on the other, two spores apparently of *Cladosporium*. It is quite possible that these were contaminations, but it is thought that they probably represent valid observations. Four silicone controls placed at intervals through the flights in the electrostatic sampler and taken out and wrapped after closing and opening the lid gave an average of 2·25 colonies, whereas nineteen proper exposures gave an average of 5·42 colonies.

Concerning results there appears to be little to say except that the air at the highest latitudes and even well south may by ordinary standards be judged on this showing to be virtually sterile in winter—as was perhaps to be expected in view of the great distance almost any disseminules would have to travel when frozen conditions obtained and snow covered most areas for 2,000 miles or more southward from the Pole. Nevertheless, it was a point worth demonstrating in view of the very wide dissemination found or postulated in other circumstances elsewhere, and it is hoped that it may still be possible later on to carry out a full summer repetition of this work in order to determine more of the situation at that season.

It may be noted that the electrostatic sampler and filters gave usually very different results, which were in most of the present instances much higher in the latter case, sometimes by more than ten times, and that there is again some correlation between biota and air-masses, as can be seen by comparing the numbers given in the second table[4] with the computed sources and extents of the air-masses in which we were flying. Thus whereas a 'lumping' of methods and groups gives an average of 1·49 bacterial plus fungal colonies per cubic foot for the March 28 'abort', during which we were flying mainly in Pacific-maritime air "with trajectory over Kamchatka, east Siberia and interior Alaska", a similar lumping of the colonies obtained from the entire North Pole flight which was started on the following day in air of relatively unfavourable, northern origin gives a figure of 0·496. It is interesting to note that the only at all high figures were obtained on the former flight, and the only ones on the polar flight that really approached them were either from exposures made near the beginning (when we may quite likely have been flying in air of relatively favourable origin) or at the very highest latitudes (where the air was much mixed and where the above-mentioned pollen grain and spores appear to have been trapped). The only slide observed in some weeks of searching to have two pollen grains upon it was exposed on the return flight from the Pole about the north coast of Alaska where there may have been a mixing of air of a relatively southern source, although this is not borne out by the bacterial and fungal colonies observed via the electrostatic sampler and filters; however, it should be noted that its fellow was the only slide from either flight which was observed on direct microscopic examination to have more than two fungal spores upon it (it had four), which suggests an airborne patchiness such as we have met before.

[1] *Nature*, **160**, 876 (1947); **162**, 379 (1948); **168**, 718 (1951).

[2] *Science*, **110**, 187 (1949).

[3] Since this paper was written and finally passed for publication, an account of the apparatus employed has appeared in *Canadian J. Bot.* (**29**, pp. 206–214, 1951).

[4] Not reproduced here, as essentials of it were previously published as Table 2 (pp. 342–43) in *Svensk Botanisk Tidskrift* (Bd. **45**, H.2; 1951) owing to delays in official clearance of the present paper, which was drafted early in 1950. Reprints of that more general paper are available on request to Nicholas Polunin, Gray Herbarium of Harvard University, Cambridge 38, Mass., U.S.A.

[5] Fournier d'Albe, E. M., *Nature*, **162**, 921 (1948). Brewer, A. W., and Palmer, H. P., *Nature*, **164**, 312 (1949). Brewer, A. W. (*voce*).

[6] Cf. Table 3 (pp. 347–48) in *Svensk Botanisk Tidskrift* (Bd. **45**, H.2; 1951) and see ref. 4 (added in proof).

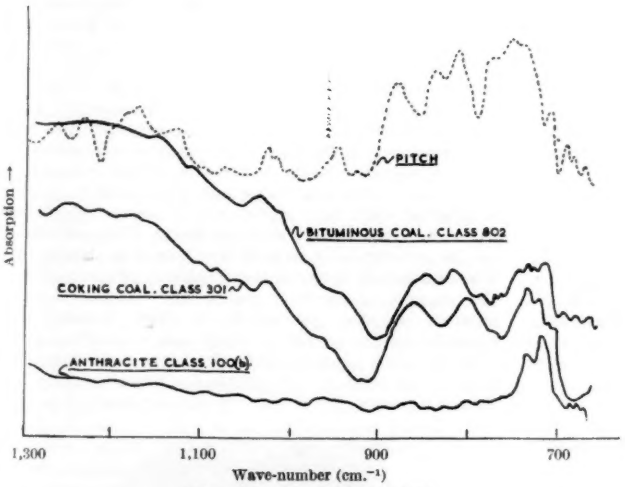
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Infra-Red Spectra of Coals

Cannon and Sutherland have reported attempts to obtain infra-red absorption spectra of coals, first by examining thin slices of coal[1] and, secondly, by dispersing the finely ground coal in 'Nujol' (liquid paraffin)[2]. Using the latter technique, they found it was essential to grind the coal to a particle-size of less than one micron before successful spectra could be obtained. Their examination was limited to the frequency-region 1,000–10,000 cm.$^{-1}$.

We have found that thin slices of coal and dry grinding of coal are both unsatisfactory. Satisfactory spectra have been obtained by the technique of grinding 1 gm. of coal together with 4 ml. of 'Nujol' for 18 hr. in a power-driven agate pestle and mortar. This suspension, in which 80 per cent of the coal particles were less than 1 micron in size, was used for preparing a cell with a layer thickness of 0·05 mm. Energy transmission was low, due to scattering of the incident radiation by reflexion from the particle surfaces, so that large slit-widths were necessary. To compensate for this scattering, backgrounds were prepared using a suspension of spectroscopic carbon in 'Nujol', prepared as for coal.



Infra-red spectra of coals and pitch

The infra-red absorption spectra (see illustration) of three coals (all of ash content less than 1 per cent) and of a low melting point pitch were obtained, over the frequency-range 750–1,300 cm.$^{-1}$, using a Grubb Parsons single-beam spectrometer. The pitch was melted on a heated rock-salt window to give a uniformly thick film.

The anthracite gives a spectrum differing considerably from those of the other two coals. It is interesting to note that organic groupings which occur in pitch also occur in coal.

No attempt has been made to assign organic groups to the absorption peaks recorded. An extensive programme is in progress for the further elucidation of these spectra.

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W. N. Adams
G. I. Jenkins

National Coal Board,
Central Research Establishment,
Stoke Orchard, Glos. June 4.

[1] Cannon and Sutherland, *Trans. Farad. Soc.*, **41**, 280 (1945).
[2] Cannon and Sutherland, *Nature*, **156**, 240 (1945).

Nature of the Solution obtained by Pyridine Extraction of Coal

In a recent communication on the internal surface of coal[1], Dryden has directed attention to the interesting agreement between (*a*) the minimum particle-size observed by Nagelschmidt and Cartwright[2] in electron micrographs of films deposited from dilute ethylenediamine extracts from coal, (*b*) particle-sizes observed in the ultramicroscopic examination of similar extracts[3], and (*c*) the order of particle-size concerned in the model of colloidal structure of coal suggested by Bangham *et al.*[4].

The solutions obtained by the pyridine extraction of coal are commonly believed to be, like the ethylenediamine extracts, essentially colloidal dispersions. Nevertheless, the average molecular weights of the substances present in such solutions are only of the order of 500–1,400, and are inconsistent with their supposed colloidal nature[5].

We have found that electron micrographs of the films formed by the evaporation of diluted pyridine extracts were almost identical in appearance with those described by Nagelschmidt and Cartwright. Examination of the particles by electron diffraction gave diffuse patterns only, resembling those for collodion; and we had therefore interpreted our electron micrographs as being merely an extension to smaller dimensions of similar but grosser aggregation phenomena observable by optical microscopy.

We have now further examined our pyridine extract solutions. Samples of the diluted pyridine solution of a coal extract ($\beta + \gamma$ fraction) and of its chloroform-soluble components (γ fraction) were spread on a glass slide and the solvent eliminated by rapid heating to 180–200° C. in a stream of nitrogen. The specimens were then kept under a vacuum of 10^{-2} cm. of mercury for about one hour. The deposits thus formed were collected on collodion, or 'Formvar', by stripping off a film cast over the deposit. The structure previously observed with the deposits disappeared as a result of this treatment. Typical electron micrographs are shown in Figs. 1, 2 and 3. The cracked portions of the films were chosen to illustrate the varnish-like appearance of the deposit. Fig. 4 shows an intermediate stage in the deposition of the material, illustrating the melting of the aggregates observed in earlier photographs. There was no evidence of the presence in the material of discrete particles.

It would have been interesting if Nagelschmidt and Cartwright had made some comment on the behaviour

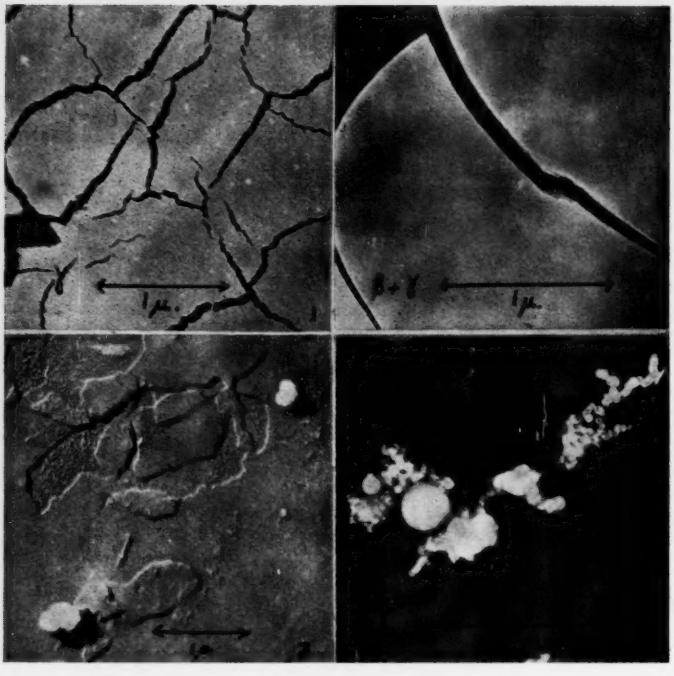

Fig. 1. γ extract: coal, C.942. Heated to 200° C. in nitrogen
Fig. 2. $\beta + \gamma$ extract: coal, C.942. Heated to 200° C. in nitrogen
Fig. 3. As Fig. 1. Gold shadowed, 45°
Fig. 4. Specimen as Fig. 1. Partly fused

of their material under electron diffraction, since the particles are of suitable size for this technique with the *E.M.*3 instrument. Resolution of the particle structure by this means might be difficult (compare the X-ray studies of soap micelles by P. A. Thiessen *et al.*[6]); but the diffraction pattern could probably be distinguished from that of the 'Formvar' substrate.

A fuller account of the work will be published elsewhere.

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H. R. Thirsk
H. E. Blayden

Department of Physical Chemistry
and Coke Research,
King's College,
Newcastle upon Tyne 1. May 15.

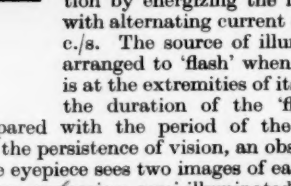
[1] Dryden, I. G. C., *Nature*, **169**, 269 (1952).
[2] Nagelschmidt, G., and Cartwright, W. J., *Nature*, **169**, 270 (1952).
[3] Kann, L., *Fuel*, **30**, 47 (1951).
[4] Bangham, D. H., *et al.*, *Fuel*, **28**, 231 (1949).
[5] Shaw, F., and Blayden, H. E. (to be published).
[6] Thiessen, P. A., *et al.*, *Z. phys. Chem.*, **156**, 447 (1931); **165**, 453 (1933); **176**, 397 (1936).

A Method of Measuring and Grading Microscopic Spherical Particles

The study of particulate matter such as dust often entails either the measurement of the individual diameters of small spherical particles viewed through a microscope, or the determination of the size distribution of such particles by counting the numbers having diameters lying within specified ranges. The conventional methods of performing these operations have not proved sufficiently accurate for some investigations being undertaken at this Unit, and a new instrument has been devised for the purpose.

The principle of the instrument consists of producing two identical coplanar images of each particle, the centres of which are separated by a variable distance. The separation between the centres when the two images are arranged to touch is equal to the diameter of the images. The two images can be formed in various ways. The method described here, besides providing critical adjustment for accurate measurement of the individual diameters, also allows adaptation for rapid grading by size of the particles.

The practical arrangement consists of a normal microscope optical system, modified by the introduction of a small mirror inclined at 45° to the vertical to reflect the light beam from the objective into a horizontal eyepiece. The mirror is mounted by its back face on to the diaphragm of a horn-type loudspeaker, and can be set into vibration by energizing the loudspeaker with alternating current of about 50 c./s. The source of illumination is arranged to 'flash' when the mirror is at the extremities of its vibration, the duration of the 'flash' being short compared with the period of the vibration. Because of the persistence of vision, an observer looking into the eyepiece sees two images of each particle, these images appearing semi-illuminated against a fully illuminated field. When the images overlap, as in the figure, the lens-shaped area common to both is completely dark and stands out in sharp contrast to the rest of the images and the field. The instrument can be set critically so that the 'lens' just disappears. The separation between the images is proportional to the energizing current, and a meter recording the current can be graduated to show directly the diameter of the particle. Preliminary results suggest that repeated readings differ from their mean by less than 3 per cent for a particle 1 μ in size and by less than 1 per cent for a particle greater than 10 μ.



The following methods for grading the particles into size-groups eliminate the recording of each individual value. In the first method it is arranged that, after adjustment of the continuously variable separation has been made, the energizing current is discriminated by amplitude and an appropriate counter triggered. In the second method the energizing current is modulated by a low-frequency

square wave. For odd half-cycles of the modulating wave the value of the current corresponds to the lower limit of a size-range, and for even half-cycles to the upper limit of the range. The images of particles within the size-range can be distinguished from others in the field of view by their characteristic feature of overlapping during odd half-cycles and not overlapping during even half-cycles. The images of particles smaller than the lower limit do not overlap during either half-cycle, while the images of particles larger than the upper limit overlap all the time. A switch enables each size-range with a corresponding counter to be selected in turn. Each time a particle with the characteristic feature mentioned above is seen, a triggering pulse (initiated by a foot switch) is routed to the counter appropriate to the size-range.

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May 29.

Interaction of Macromolecules and Fibrinogen

RICKETTS[1] has described an interaction between dextran and fibrinogen. It was therefore decided to investigate the interaction of several other polymers, used in transfusion therapy, with fibrinogen of human and bovine origin.

Dextran fractions of intrinsic viscosities 0·41, 0·31, 0·24 and 0·06, and possessing branching factors (ratios of α 1–6 glucosidic linkage to α 1–4 glucosidic linkage) varying from 4 : 1 to 11 : 1 were used. A commercial preparation of polyvinylpyrrolidone, gum acacia in saline, and a hydrolysed laminarin fraction of intrinsic viscosity 0·2, were also investigated.

Solutions containing 1·5, 3·0 and 6·0 per cent of the polymers in 0·9 per cent saline were each added to equal volumes of solutions containing 0·4, 0·8 and 1·5 per cent of fibrinogen also in 0·9 per cent saline. The tests were made under the following conditions.

(1) *Solutions mixed at 25° C. and then placed in a refrigerator at 4° C. for 16 hr.* All the dextran fractions, with the exception of the one of intrinsic viscosity 0·06, gave a precipitate. Polyvinylpyrrolidone, laminarin and gum saline gave precipitates of similar magnitude to the dextran fractions of intrinsic viscosity 0·41 and 0·24. The amount of precipitate was greater with increasing concentrations of both fibrinogen and polymer.

(2) *Solutions mixed at 37° C. and then placed in an incubator at 37° C. for 16 hr.* Only laminarin formed an insoluble complex at this temperature; but when the temperature of the remaining solutions was lowered to 4° C., precipitation of the complex took place with each of the other polymers.

Dilutions of the polymers at concentrations 0·75, 1·5 and 3 per cent were made at 37° C. in plasma. An aliquot was incubated at 37° C. during 8 hr. and another at 4° C. during a similar period. No precipitation occurred with any polymer at either temperature. However, complex formation did take place in a 5 per cent albumin solution containing 1 per cent sodium citrate, 0·9 per cent saline and 0·4 per cent fibrinogen, the reaction being carried out as in method (1). This indicates that it is not just simple solubility in citrate or albumin which is preventing the formation of the complex. The dextran–fibrinogen complex was prepared on a larger scale and injected intravenously into mice at a dose-level of 300 mgm. per kgm. of body-weight. None of the mice showed any untoward reaction.

It is well known that dextran fractions above a certain critical molecular size, namely, 59,000, increase the sedimentation-rate of erythrocytes[2]. Solutions containing 1 and 2 per cent of dextran (intrinsic viscosity 0·31) were made in a 5 per cent albumin solution. Red blood cells, washed free from plasma with saline, were added to this solution; the erythrocyte sedimentation-rate in the albumin–dextran solution was of the same order of magnitude as that of blood containing a similar dextran concentration. Hence the removal of fibrinogen had not affected the sedimentation-rate of erythrocytes. The electrophoretic pattern of plasma containing dextran is being examined to see if it is possible to detect any evidence of a soluble dextran–fibrinogen complex.

These preliminary investigations indicate that the property of forming a complex with fibrinogen is not peculiar to dextran but is also possessed by polyvinylpyrrolidone, gum acacia and laminarin, and since the complex formed contains only approximately 1 per cent of the polymer in solution and 10 per cent of fibrinogen, it probably would have no pathological significance.

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July 3.

[1] Ricketts, C. R., *Nature*, **169**, 970 (1952).
[2] Thorsén, G., *Acta Chir. Scand.*, supp. 154 (1950).

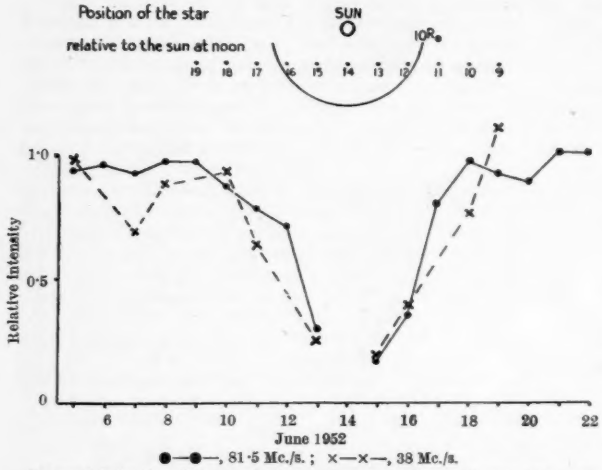
Occultation of a Radio Star by the Solar Corona

IT has been suggested[1] that the radiation from a radio star might be cut off by refraction in the solar corona, even when the angular separation of the sun and the star is several times the angular radius of the visible disk ($R_\odot$). The existing data on the coronal electron density have been used for predicting the effective radius of the sun for occultation on various frequencies[1]. Link[2] has calculated the circumstances of the occultation for 1952 and has also shown that the observed intensity of the radiation from the radio star should increase before the actual occultation. Attempts were made to observe these effects in June 1950 and 1951 when the radio star in Taurus (05·01) passed within an angular distance of about 4·5 $R_\odot$ from the sun's centre, but intense sunspot radiation prevented any useful results being obtained.

Measurements of the intensity of the radio star 05·01 were again made on frequencies of 210, 81·5 and 38 Mc./s. during the period June 5–20, 1952; as in the earlier observations, interferometers of large resolving power were used for reducing the amplitude of the record from the undisturbed sun. In addition, the position of the star was measured each day on 81·5 Mc./s.

No accurate observations were possible on 210 Mc./s., owing to the disturbing effect of a small sunspot; but reliable results were obtained on both 81·5

and 38 Mc./s. throughout most of the period. The results of the intensity measurements are shown in the accompanying graph. The measurements on 38 Mc./s. were less accurate than those on 81·5 Mc./s., due to the limited angular discrimination of the aerial system.



Apparent intensity of the radio star in Taurus as it passed near the sun's southern limb

It was predicted that on 38 Mc./s. a well-defined occultation should occur at a separation of about $5 \cdot 2\ R_{\odot}$, little effect being observable on 81·5 Mc./s. However, as shown by the graph, a decrease of amplitude of record occurred on both frequencies, even when the separation was as great as $10\ R_{\odot}$. The position measurements (which were possible on all days except June 13, 14 and 15) showed no deviation greater than 2′ of arc.

The observed reduction in amplitude of the records could imply an actual reduction in flux density at the earth. On the other hand, since interferometers of considerable resolving power were used, it is possible that the reduction was due to an apparent increase in the angular diameter of the star. Such an increase in diameter might be caused by irregularities of electron density in the outer corona between 4 and $10\ R_{\odot}$. The observations at 38 Mc./s. would be consistent with a source the apparent diameter of which increased from about 15′ of arc when the separation was $10\ R_{\odot}$, to about 45′ of arc at $4 \cdot 5\ R_{\odot}$. On 81·5 Mc./s. the corresponding figures are 8′ and 25′.

The interpretation of these results in terms of the structure of the outer solar corona will be considered in a separate paper.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research. One of us (F. G. S.) is indebted to the Royal Commission for the Exhibition of 1851 for a senior studentship.

K. E. Machin
F. G. Smith

Cavendish Laboratory,
Cambridge.
June 27.

[1] Machin, K. E., and Smith, F. G., *Nature*, **168**, 599 (1951).
[2] Link, F., *Bull. Cent. Ast. Inst. Czechoslovakia*, **3**, 6 (1952).

Heats of Formation of Mercury Dimethyl, Diethyl and Diphenyl and some Associated Bond Dissociation Energies

The values obtained by Berthelot[1] for the heats of formation of some of the organic compounds of mercury have been in doubt for some time. A re-examination of these compounds is especially important, since their heats of formation can be combined with other recent thermochemical data to give the mean bond energy of the C—Hg bond and the heats of formation of various alkyl and aryl halides. The values for the halides throw considerable light on C—halogen bond dissociation energies and the C—H dissociation energy in benzene.

The problem was approached through the heat of combustion of mercury dimethyl, diethyl and diphenyl, and in every case a result was obtained which differed appreciably from that of Berthelot.

The materials were prepared by the method of Gilman[2] and, in the case of the liquids, carefully purified by repeated fractionation. The mercury diphenyl was purified by recrystallization from methanol.

The liquids were distilled under high vacuum into thin-walled glass capsules which were then sealed. The solid diphenyl was compressed into pellets. Combustion was carried out in a stainless steel bomb, and, since incomplete combustion to the extent of 1–2 per cent was observed, the products of combustion were analysed and the calculation of results based on the weight of carbon dioxide found. Appreciable amounts of mercuric oxide were also present and these were estimated and a correction made. The following values have been obtained for the heat of formation of the mercury compounds:

$$Q_f(Hg(CH_3)_2, 1) = -14 \cdot 3 \pm 0 \cdot 1 \text{ k.cal./mole.}$$

This is markedly different from Berthelot's result of $-36 \cdot 8$ k.cal/mole, but agrees excellently with the value $-14 \cdot 31 \pm 1 \cdot 85$ k.cal./mole derived by Skinner[3] and his co-workers, from a thermochemical study of the reactions of mercury dimethyl with alcoholic solutions of halogens and mercuric halides:

$$Q_f(Hg(C_2H_5)_2, 1) = -6 \cdot 5 \pm 0 \cdot 2 \text{ k.cal./mole.}$$

This again disagrees with Berthelot ($-15 \cdot 7$ k.cal./mole) but is much closer to the Skinner[4] value of $-9 \cdot 9 \pm 1 \cdot 7$ k.cal./mole, especially if the estimated error is taken into account.

$$Q_f(Hg(C_6H_5)_2, c) = -71 \cdot 6 \pm 0 \cdot 3 \text{ k.cal./mole.}$$

Berthelot's value is $-92 \cdot 1$ k.cal./mole. Skinner[4] quotes two values, $-67 \cdot 1 \pm 3$ and $-56 \cdot 5 \pm 3$ k.cal./mole, the large difference being due to considerable uncertainty as to the correct value for the heat of formation of phenyl bromide. The thermochemical data obtained by Skinner *et al.*[3,4] can be combined with our values for the heat of formation of the mercury compounds to give the following results:

$Q_f(CH_3Br, g) = 8 \cdot 6$ k.cal./mole	$Q_f(CH_3I, 1) = 2 \cdot 3$ k.cal./mole
$Q_f(C_2H_5Br, 1) = 22 \cdot 1$,,	$Q_f(C_2H_5I, 1) = 10 \cdot 13$,,
$Q_f(C_6H_5Br, 1) = -16 \cdot 3$,,	$Q_f(C_6H_5I, 1) = -28 \cdot 8$,,

From these values, knowing the C—H dissociation energy in the hydrocarbon, the following C—halogen bond-dissociation energies may be found:

$D(CH_3 - Br) = 67{\cdot}8$ k.cal./mole $D(CH_3 - I) = 53{\cdot}4$ k.cal./mole
$D(C_6H_5 - Br) = 66{\cdot}5$ " $D(C_6H_5 - I) = 52{\cdot}6$ "

In view of the possible errors in the assumed data, we feel that the above dissociation energies are subject to an uncertainty of about ± 2 k.cal./mole.

Butler and Polanyi[5] have measured the C—I dissociation energy in phenyl iodide by means of pyrolytic decomposition. Szwarc[6] has repeated this work and obtained a higher value. Also, Szwarc and Williams[7] have found the C—Br dissociation energy in phenyl bromide.

From these results and the heats of formation of gaseous phenyl iodide, phenyl bromide and benzene, the heat of formation of the phenyl radical and the C—H dissociation energy in benzene may be derived.

C—hal. dissociation energy in k.cal./mole		$Qf(C_6H_5)$ in k.cal./mole	$D(C_6H_5 - H)$ in k.cal./mole
$D(Ph - I) \sim 55$	(ref. 5)	$\sim -67{\cdot}9$	~ 100
$D(Ph - I) > 57$	(ref. 6)	~ -70	~ 102
$D(Ph - Br) = 70{\cdot}9$	(ref. 7)	$-69{\cdot}7$	102

Finally, the measured heats of formation enable us to calculate the sum of the Hg—C dissociation energies in the compounds investigated:

$D(Hg - Me_2) = 57{\cdot}1 \pm 2$ k.cal./mole
$D(Hg - Et_2) = 48{\cdot}5$ k.cal./mole
$D(Hg - Ph_2) = 60$ "
} limits of error uncertain

We should like to add that our experimental results could not have been extended so widely but for the valuable work carried out on the thermochemistry of these mercury compounds by Skinner and his co-workers in Manchester.

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Precursors of Protoporphyrin in *Chlorella*

On the basis of studies of *Chlorella* mutants a biosynthetic chain has been formulated leading from protoporphyrin through Mg protoporphyrin, Mg vinyl pheoporphyrin and protochlorophyll finally to chlorophyll[1]. We have recently isolated a *Chlorella* mutant which promises to reveal some of the precursor porphyrins leading up to protoporphyrin.

This mutant, W_5B-17, arose from an irradiation with ultra-violet light of the protoporphyrin-producing W_5B cells. The W_5B-17 cells appear almost colourless or pale brown. On solid medium they leak out porphyrins which are more soluble than protoporphyrin and discolour the agar pink. It has been found possible to grow this mutant in liquid culture without diminishing the pigment yield. Starting with a colourless medium, by the end of the week the medium turns a deep chocolate-brown colour due to the accumulation of porphyrins produced by the mutant. From fifteen litres of medium it is estimated that a total of approximately 1·5 gm. of porphyrins is produced.

Preliminary studies of the porphyrins from this mutant indicate that it consists of a number of components. From the R_F values of the paper chromatograms[2] it is concluded that there are present, in this mixture, porphyrins containing 2, 3, 4, 5 and possibly 8 carboxyls. The fraction containing two carboxyl groups per molecule represents most of the porphyrin produced: it consists of protoporphyrin and two additional main porphyrin components. One of these main components may be an immediate precursor of protoporphyrin since its absorption spectrum indicates that it contains one vinyl group in contrast to the two vinyl groups of protoporphyrin.

In the past, workers who have attempted a study of porphyrin precursors have been limited in material primarily to the porphyrins excreted by patients with some metabolic lesion in their porphyrin metabolism. Such studies have been difficult because the disease is rare, the isolation of the pigments tedious and the yields small. This new mutant now makes available unlimited quantities of several of the protoporphyrin precursors. It is hoped that studies on this alga will not only provide information on the important biosynthetic chain of heme and chlorophyll but also may eventually contribute to an understanding of porphyrinuric diseases in man.

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Structure of Lanostenol

Recently, the molecular structure of lanostadienol (lanosterol), $C_{30}H_{50}O$, an important 'triterpenoid' constituent of wool-wax, has been studied intensively. Ruzicka *et al.*[1] and Barton, McGhie *et al.*[2] have suggested three possible formulæ and, considering the evidence available, were unable to decide between them. Earlier, we had begun an X-ray structure analysis to provide unequivocal proof of the molecular structure of lanostadienol. This investigation has provided, in addition, a complete description of the stereochemistry of the molecule, avoiding the complex orthodox methods of stereochemistry. From earlier work, lanostadienol is known to contain four rings, one inert double-bond and one active double bond in the terminal *iso*propylidene group of the long side-chain. Hydrogenation of the active double-bond yields lanostenol, and the iodoacetate of this compound[3] was selected as a suitable 'heavy-atom' derivative for the structure analysis.

The crystals of lanostenol iodoacetate, $C_{32}H_{53}O_2I$, are orthorhombic, the space group being $P2_12_12_1$. There are four molecules in the unit-cell of dimensions: $a = 7{\cdot}6$, $b = 10{\cdot}9$, $c = 38{\cdot}6$ A. The x, y and z parameters of the iodine atoms were determined from Patterson F^2 syntheses of the projections along the a and b axes. The first Fourier syntheses, ρ ($0yz$) and ρ ($x0z$) were computed with the majority of signs fixed by the contributions of the iodine atoms, and from these electron-density distributions the general disposition of the molecule in the unit cell was evident. Due to the existence of false peaks adjacent to the iodine atoms, the initial difficulty in solving the structure was the location of the acetate group. However, after testing various molecular models, the detailed configuration of the molecule was achieved, refinement proceeding by successive Fourier syntheses until the reliability factors, $\frac{\Sigma \mid F_o - F_c \mid}{\Sigma \mid F_o \mid}$, were reduced to 22 and 25 per cent

for the *0kl* and *h0l* sets of reflexions respectively. A section of the electron-density distribution projected on the *bc* plane and selected to display one complete molecule is shown in Fig. 1,*a*. The corresponding diagram of the molecule is given in Fig. 1,*b*. The *b* axis projection (not shown here) provides a relatively clear picture of the molecule viewed approximately side-on to its main length. The combined information in the two projections provides a precise determination of the molecular structure and stereochemistry of lanostenol.

The formal representation of the chemical structure of lanostenol is given in Fig. 2, the ring skeleton consisting of three six-membered rings and one five-membered ring fused in a manner similar to that observed in cholesterol. The rings *A*/*B* and *C*/*D* are *trans*-fused, with the presence of the inert double-bond at C(9)–C(10) deduced from the distortion of the *B*/*C* ring system apparent in Fig. 1,*a*. Due to the presence of the double-bond at C(9)–C(10) the ring system *B*/*C* should be symmetrical; but the fusion of the five-membered ring *D* to the six-membered ring *C* distorts the latter (see Figs. 1,*a* and *b*). The *gem*-dimethyl group C(18), C(19) is attached to C(1), while single angular methyl groups C(20), C(21) and C(22) are attached to C(5), C(13) and C(14) respectively. The *iso*-octane chain is attached by C(23) to C(17) of ring *D*.

The molecular structure, determined by this method, is in agreement with the partial formula of McGhie *et al.*[4] and Barton *et al.*[5] for the ring system

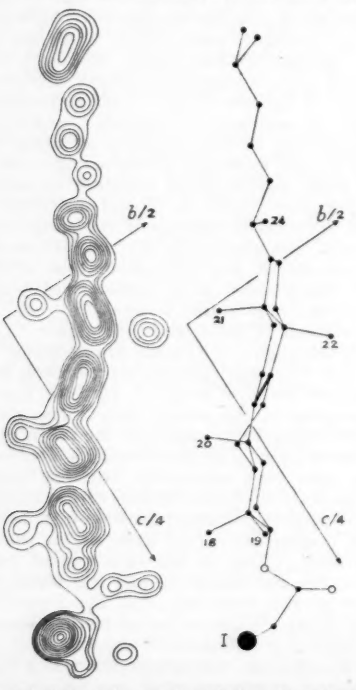

Fig. 1. (*a*) Part of the *a*-axis projection of electron-density distribution, illustrating one molecule. (*b*) Corresponding diagram of the molecule. The double-bond at C(9)—C(10) is shown as a thicker line

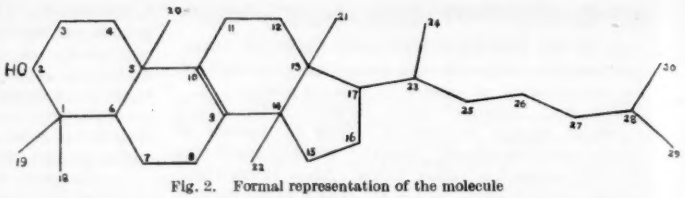

Fig. 2. Formal representation of the molecule

A/*B*/*C* and their associated methyl groups, but disproves their suggestion that ring *D* is six-membered. In a series of papers[6] on chemical and spectrophotometric studies, Ruzicka *et al.* gave structural evidence which agrees with that of Barton *et al.*[5] and McGhie *et al.*[4] regarding the part of the molecule up to ring *C*; in addition, they determined the structure of the long side-chain[7]. In their latest publication[1], Ruzicka *et al.* have proposed a structural formula in which ring *D* is five-membered; but there are three possible molecular structures, depending on whether C(23) is linked to C(15), C(16) or C(17). Barton *et al.*[2] have obtained supporting evidence for the basic correctness of Ruzicka's[1] structures; but, on the basis of the 'isoprene' rule, they select the point of attachment of C(23) as C(15) or C(16). From our analysis, it has been made clear that the point of linkage is C(17).

The structural formula for lanostenol cannot be fitted to the 'isoprene' rule which normally applies to triterpenes. It is of interest in this connexion that this compound co-exists with cholesterol in wool-wax and with ergosterol in yeast. The question therefore arises as to whether lanostenol and the related compounds with the same carbon skeleton, lanostadienol, agnostadienol and agnostatrienol, should be considered triterpenes or trimethylated sterols.

A more detailed report of the structure analysis and of the stereochemistry of the molecule will be given at a later date.

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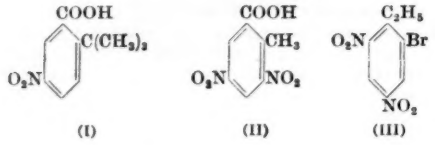
Steric Effect of the *tert.*-Butyl Group

When *tert.*-butylbenzene is mono-nitrated the main product is the *para* isomer; but toluene gives largely the *ortho*[1-3]. Again, when *p-tert.*-butyltoluene is dinitrated, 4-*tert.*-butyl-2 : 6-dinitrotoluene is formed[4]. Substitution *ortho* to the *tert.*-butyl group is clearly hindered by the steric effect of this large group[1,2].

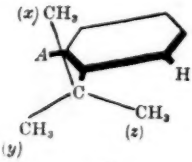
On dinitration of *tert.*-butylbenzene with fuming nitric acid[5] or warm mixed acid[6], the product is 2 : 4-dinitro-*tert.*-butylbenzene. Still further nitration gives a trinitro product of unknown orientation[5]. It is possible from what follows that this may not be 2 : 4 : 6-*tert.*-butylbenzene.

It has now been observed that *o-tert.*-butylbenzoic acid can readily be nitrated with nitric acid to give 2-*tert.*-butyl-5-nitrobenzoic acid (I) as colourless needles (m.p. 170° C.); but further nitration of this acid or its ethyl ester with fuming nitric acid cannot be accomplished, nor is bromination by the powerful method of Derbyshire and Waters[7] effective.

It is clear that in (I) and probably also in 2 : 4-dinitro-*tert.*-butylbenzene there is considerable resistance to the entry *ortho* to the *tert.*-butyl group of a second substituent. No such difficulty occurs with the methyl group, for *o*-toluic acid on nitration gives a mixture of the 3- and 5- mono-nitro products, either of which on further nitration yields 3 : 5-dinitro-2-toluic acid (II)[8]. Nor is 2 : 6-substitution around the ethyl group difficult, for it has been noted that 2 : 4-dinitroethylbenzene is smoothly brominated by the Derbyshire and Waters method to give 2-bromo-4 : 6-dinitroethylbenzene (III) as a golden-yellow oil (b.p. 190° C. at 15 mm.).



(I) (II) (III)



(IV)

It is scarcely to be expected that, if one group can enter *ortho* to the *tert.*-butyl group, another of roughly equal size cannot enter the second *ortho* position. The deactivating effect of the first group can scarcely be very important, for it has been pointed out that nitro[9] and probably carboxyl[10] next to large groups are not coplanar with the ring and therefore will exert much smaller electromeric effects.

Some dissymmetry of the *tert.*-butyl group is implied. Bending of the C_{ar}–C_{al} bond comes first to mind, but a more likely explanation is possible if the *tert.*-butyl group is likened to a 'blown-out' umbrella. The *ortho* group (*A* in IV) will fit nicely between two spokes of the umbrella (methyl groups *x* and *y*) but the third spoke (methyl group *z*) will project towards the other *ortho* position, so inhibiting effectively the entry of a second *ortho* substituent. Methyl, of course, has the same shape as *tert.*-butyl, but is obviously too small to block the second *ortho* position.

Insufficient is known about the transition state in aromatic electrophilic substitution to say whether the projecting methyl group acts by preventing the *ortho* hydrogen atom from taking up the position for ejection or by blocking the approach of the attacking cation.

A fuller description of the new compounds mentioned, together with others, will be given elsewhere. One of us (F. H. C. S.) is indebted to the Ministry of Education for Northern Ireland for a grant.

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Mollusc Control and Fish-Farming in Central Africa

IN Africa, fish-ponds and other waters may easily become infested with large numbers of different snails, including the intermediate hosts of bilharzia[1]. This problem is always kept in mind[2], as well as the objections of medical people and others against large-scale fish-farming over wide areas; but in many places fish-farming is the only possibility of providing the natives with animal proteins. Mollusc control must therefore be worked out without interference with the production of fish, and such methods as the use of molluscicides (copper salts and other antibiotics) have to be avoided[3]. There remains biological control; but this also has its difficulties. There is the possibility of using birds, for example, ducks[4], or amphibians; but fishes only will be dealt with here.

Many mollusc-eating fishes are already known in Africa, for example, *Astatoreochromis alluaudi*, *Synodontis* sp.[5], *Clarias gariepinus*[1], etc.; but they are not yet used in ponds so their practical value remains uncertain.

Work done at this station on a local cichlid, *Serranochromis* sp. (presumably *S. macrocephala*), has given valuable information on snail control. Although the study of the feeding habits of this fish is not yet completed, the data already obtained are worth considering.

In rivers, this fish eats, among other organisms, different species of snails (58 per cent of thirty-five fishes examined). Since the shells are broken, it is often difficult to determine exactly which are the species involved; but we have been able to recognize Planorbidæ, Ancylidæ and Melaniidæ.

This fish eats the different snails that we have found in the rivers from where our specimens were taken. The only exception is the large *Lanistes*, which is not known as a bilharzia host.

In ponds, the feeding habits of *Serranochromis* are slightly different. It eats more molluscs than it does in rivers: out of fifty fishes examined, 72 per cent have fed on snails, principally *Biomphalaria* and *Limnæa*.

A pond of about 0·1 acre, densely populated with *Physopsis* and *Biomphalaria*, was stocked with *S. macrocephala*. During the first month 87 per cent of the fish captured had eaten snails; after two months,

this percentage had fallen to 44. A complete drying of the pond after three months did not reveal the existence of any small snails. The fact that some big *Physopsis* specimens survived was probably in relation with the small size of the fish (± 14 cm.). In a spawning pond with big breeders all snails had disappeared. Since this fish does not feed exclusively on snails, the complete disappearance of the latter does not harm his growth. Insect larvæ, crustaceans, other fishes, tadpoles, worms, etc., are eaten in different proportions.

In our ponds *Serranochromis* has already successfully spawned and we have many data about breeding habits, growth, resistance to manipulation, etc. We hope to have enough fingerlings before the end of the year to start distribution.

It may be added that this fish is a good sporting-fish and very palatable.

A few other species of fishes feeding on snails and mussels were studied at the same time. Among other siluroids we should like to mention *Chrysichtys mabusi* which, in its natural environment, feeds on molluscs. Curiously enough, even the thin shells of *Mutela* remain unbroken all through the digestive tract. *Chrysichtys mabusi* seems to be important for mollusc control in large permanent waters.

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Change in the Composition of the Bottom Fauna of the Dogger Bank Area

F. M. Davis[1] has shown that, during the quantitative bottom investigations carried out with the Petersen grab over the Dogger Bank area of the North Sea during 1921–23, there was a pronounced dominance of the bivalves *Spisula subtruncata* (da Costa) and *Mactra corallina* (L.).

The Danish Commission for Fishery and Sea Investigations in May 1950 and 1951 undertook a similar investigation in the area with the research vessel *Dana*, comprising about two hundred samples taken with the 0·2 sq. m. van Veen and Petersen grabs. It was found that the above-mentioned species had decreased considerably in number as compared with the previous investigations. It also appeared that most other species recorded by Davis had increased in number.

Below, the finds made by Davis during voyage 48 (60 sq. m. of samples with the 0·2 sq. m. Petersen grab in October 1922), covering the central and western parts of the bank, are compared with the samples taken in May 1951 in the same area (11 sq. m. of samples with the 0·2 sq. m. van Veen and Petersen grabs). The difference in season of the year between the two investigations may be of some importance. However, during Davis's investigations the general aspect of the composition of the fauna did not change markedly with the seasons. The number per sq. m. of animals of different systematic groups is shown in the accompanying table.

	No. per sq. m.	
	Davis (Oct. 1922)	*Dana* (May 1951)
Spisula subtruncata	272	5
Mactra corallina	11	1
Other species of bivalves	4	43
Polychæta	4	70
Echinoderma	4	28
Other groups	8	65
Total	303	212
excl. *S. subtr.* and *M. cor.*	20	206

The total number of animals per sq. m. has decreased by one-third, though species other than *Spisula subtruncata* and *Mactra corallina* have, on an average, increased their numbers about ten times. This may be due to the presence of a greater amount of O-group animals of summer-spawning species in the autumn investigation than in the spring investigation. (No marked difference in the efficiency of the two kinds of grabs was found.)

In 1951 the following five species were the most numerous in the area (unbracketed: number per sq. m. in 1951; bracketed: number per sq. m. in 1922):

Tellina fabula Gmelin	22	(0·5)
Ophelia limacina Rathke	14	(0·3)
Ophiura albida Forbes	11	(0·8)
Echinocardium cordatum Pennant	8	(1)
Eone nordmanni Malmgren	7	(0)
(*Amphipoda* not yet determined).		

Eone nordmanni was not recorded by Davis, but may have been confused with *Goniada maculata* Ørsted (Davis's voy. No. 48: 0·3; pres. inv. 2·9 per sq. m.). However, some other species, which are now present in fairly large quantities, were not found during Davis's voyage 48:

Echinocyamus pusillus (O. F. Müller)	6
Myriochele heeri Malmgren	5
Cerianthus lloydii Gosse	3

Since *S. subtruncata* and *M. corallina*, which have decreased in number, represent a southern faunal element of the North Sea, the unusually cold winters of 1940–42 and especially 1947 may have influenced their occurrence. However, the catastrophic effect of severe winters on stocks of marine animals with a pelagic larval development will normally soon be counteracted by a heavy spat-fall of the same species, since the amount of larvæ produced by the reduced parental stock is sufficient for a quick renewal of the population[2]. In 1950 and 1951 the greater part of the specimens of *S. subtruncata* and *M. corallina* were obviously very old. This indicates a failure of spat-fall during the later years, showing an interfering of factors other than the effect of severe winters.

What brought about the changed composition of the fauna is still an unsolved question because we know very little of the stability of marine animal communities. In fact, it is not known whether the difference observed between the composition of the fauna during the two periods of investigation is indicative of a fairly constant change from one state of balance to another, or whether it merely indicates the degree of fluctuation in the said area under relatively stable conditions of environment.

It is intended to continue the investigations. Later, a detailed report will be published elsewhere.

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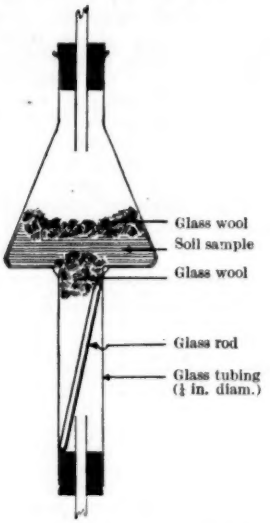
Modification of a Soil Percolation Apparatus for Soils of a High Organic Matter Content

During recent investigations of a number of soils the percolation method introduced by Schloesing and Müntz[1] was employed. The apparatus used was similar to that devised by Audus[2], as modified and described by Chase[3].

It was found that the reacting solution did not percolate through soils of a high organic matter content after the first few minutes, even when sterile sand, or glass beads, or glass wool had been mixed with the soil. It was apparent that a further modification of the apparatus was required to obtain adequate percolation with soils of this nature.



In order to permit the expansion of the soil during percolation the straight glass column was replaced by the apparatus shown in the accompanying diagram. A hole was blown in the bottom of an Erlenmeyer flask of 125-ml. capacity. A short length of 1¼-in. diameter glass tubing was sealed to the opening thus made. A pad of glass wool was inserted into this tube so as to protrude slightly into the flask; it was held in position by a suitable length of glass rod. The soil sample was placed in the flask and covered by a pad of glass wool to prevent excessive disturbance of the soil by the impact of the drops of the percolating fluid.

This alteration in the shape of the column used for containing the soil has permitted the investigation of soils which could not previously be studied by this method.

One of the authors (T. M. B. P.) wishes to express his thanks to the National Research Council of Canada for the award of a scholarship and permission to publish this note.

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Colour Change in the Echinoid, *Diadema antillarum*, Philippi

Physiological colour change has been but rarely reported in echinoderms[1]. Mortensen[2], in a footnote, makes cautious reference to the possibility of such changes occurring in *Diadema antillarum*; but it is clear that he was not aware of the striking manifestation of the phenomenon reported here, which occurs in young forms of this species. Indications of the existence of a rhythmic change in colour persisting under constant external conditions do not appear to have been reported previously in this form, nor indeed, so far as I am aware, in any other echinoderm.

By day, and in strong light, the young *Diadema* is almost uniformly black (Fig. 1). The spines (which have been cut short so as not to obscure the test) are banded with black and white; but their bases are always black.

By night, the sides of the test and the spine bases become pale grey, and in parts almost white, while aborally the test develops a strikingly brilliant white pattern in the form of a star around the periproct and enclosing the madreporite, extending into five interambulacral rays which bifurcate toward the ambitus (Fig. 3). Remarkable brilliant blue iridescent colours are to be seen at the edges of the white pattern.

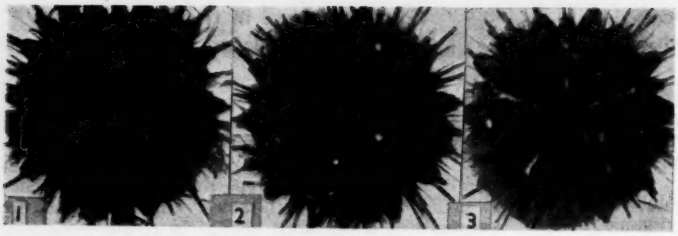
The change from the pale into the dark phase can readily be observed if the animal is placed under a 40-W. lamp, and requires 60–90 min. at 28° C. for the full range. A narrow beam of light projected on to the test brings about a localized development of the dark colour.

Examination under a low-power binocular shows that these changes are largely due to the dispersion and concentration of melanin in superficial chromatophores[1]. As the pigment disperses, there is not only an overall darkening, but also the white pattern becomes invaded by dispersing pigment, breaking up into isolated portions and eventually disappearing. During this time, the whiteness gives place to lilac and then brilliant blue, so that dispersion of light by melanin may also be involved in the play of colours that ensues.

The phenomenon is independent of the central nervous system or deeply situated nerve elements, since it occurs with equal readiness in small isolated pieces of test which have been scraped clean inside. It therefore appears to be due to the direct action of light on the chromatophores; but the possible existence of a localized superficial skin reflex, or the localized production and action of humoral agents, must be admitted.

Indications of a rhythmic colour change, independent of external lighting conditions, can be obtained by keeping an urchin in a light-proof tank. It will be found to darken distinctly during the day, and to assume characteristics intermediate between the pale and dark phases (Fig. 2). Further experiments are required, however, before it can be claimed that the temperature factor has been completely eliminated. Again, this change can be shown to be independent of the central nervous system.

As the young forms age, the colour changes become less striking and may largely disappear—a fact which may be related to the accumulation of melanin in these forms, for the change is still marked in albinotic or partially albinotic forms which are not uncommon in Jamaica. There is thus a morphological, as well as a physiological, colour change.



Photographs of young *Diadema* (diameter of test, 18·0 mm.). (1) Dark phase (photographed at 10.0 a.m. after being in sunlight); (2) intermediate phase (photographed at 10.0 a.m. after being in light-proof tank for 23 hr.); (3) pale phase (photographed at 8.0 p.m. after being in darkness for 3 hr.).

These photographs are of the same animal, using the same camera, illumination and plates. They were developed simultaneously in the same tank, printed on the same paper and given equal exposures both for photographing and printing

Since it has already been shown[4] that the whole surface of *Diadema* is remarkably sensitive to changes in light intensity, and moreover that the sensitivity increases markedly in the pale phase and declines in the dark, the dispersed superficial pigment in strong light may well serve as a protective shield for more deeply situated and widely scattered light-sensitive elements.

A full account of the investigation will be published in the near future.

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The 'Capacitation' of the Mammalian Sperm

It was shown recently[1] that sperms injected into the periovarian sac of the rat after ovulation did not begin to enter the eggs until four or five hours later. In the rabbit, too, sperms introduced into the Fallopian tubes shortly *after* ovulation seldom penetrated the eggs; but if sperms were introduced a few hours *before* ovulation, the majority of the eggs were later observed to be fertilized. Chang[2] reported similar findings in the rabbit, and also showed that sperms, injected into the Fallopian tubes after ovulation, were able to penetrate a larger proportion of eggs if they had first spent about five hours in the uterus of another rabbit.

The conclusion drawn by both workers was that, in rats and rabbits, the sperm must undergo some form of physiological change or capacitation before it is capable of penetrating the egg. The need for such a change in the sperm has not been postulated before on direct evidence, and further confirmation is desirable. In the investigations already mentioned, the animals were necessarily subjected to laparotomy and the sperms to manipulation *in vitro*. Both these procedures may render somewhat abnormal the circumstances in which the penetration of the egg is to take place, and the following results are therefore of interest because they have been obtained with a minimum of experimental interference.

Mature female rats were selected for œstrus by examining the vaginal smear between 6.0 and 7.0 a.m. and were placed in cages with males for 10–15 min. between 7.0 and 7.30 a.m. That ovulation is normally complete at this time was shown in a preliminary test by the recovery of eight or more eggs from the Fallopian tubes of sixteen out of twenty rats which were killed between 5.0 and 7.0 a.m. The females which showed evidence of copulation were selected, and individuals were killed at 1, 2, 2½, 3, 4, 5 and 6 hr. later. The Fallopian tubes were separated from the uteri by severing the isthmus of the tube in order to avoid contamination with sperms from the uterus. The distended portion of the ampulla was incised to permit the eggs in cumulus, together with the surrounding fluid, to escape on to a slide. The tube was discarded, and a coverslip with 'Vaseline' on the edges was placed over the preparation. The eggs were inspected to see if sperm penetration had occurred, and the number of sperms in the cumulus and surrounding fluid was counted. Results were obtained from a total of seventy-five rats (see table).

Mean Number of Sperms Observed about the Eggs, and Total Number of Eggs and Number of Penetrated Eggs Recovered from Rats Killed at the Specified Hours after Coitus

Hours after coitus	Number of rats used	Mean number of sperms about eggs	Total eggs	Penetrated eggs	Per cent penetrated eggs
1	10	6·6	74	0	0
2	15	20·6	139	1	0·7
2·5	10	33·5	96	21	21·9
3	10	32·1	88	39	44·3
4	10	49·9	94	65	69·1
5	10	55·4	91	78	85·7
6	10	59·6	82	80	97·6

The number of sperms found in the cumulus and surrounding fluid increased from a mean of 6·6 per tube at 1 hr. after coitus to a mean of 59·6 per tube at 6 hr. In spite of the presence of sperms, none of the eggs examined at 1 hr., and only 1 out of 139 eggs examined at 2 hr., were penetrated. At later hours, increasingly larger numbers of sperms were seen about the eggs and increasingly larger proportions of the eggs were found to contain sperms. At 6 hr. after coitus, eighty of the eighty-two eggs recovered (97·6 per cent) were penetrated.

Clearly, there is a delay of about two hours before sperm penetration of the eggs commences, and this is interpreted as support for the hypothesis that a period for capacitation is required by the sperm before it can penetrate the zona pellucida. Thereafter sperm penetration proceeds readily.

I am grateful to Miss H. N. Turner for advice on the significance of results, and to my assistant, G. S. Thring, for his careful work.

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[2] Chang, M. C., *Nature*, **168**, 697 (1951).

Rediscovery of the Ophiuroid Genus *Ctenamphiura* Verril

On September 10, 1874, H.M.S. *Challenger*, while dredging at Station 188, at the western end of Torres Strait, obtained from 28 fathoms two specimens of an amphiurid which afterwards became the genotype of the monotypic genus *Ctenamphiura*, receiving the name *Ctenamphiura maxima* (Lyman, 1879). It is remarkable among amphiurids for its robust build, the fact that the outer oral papillæ far exceed in size the infradental pair, for its very large tentacle scales, tumid disk and thick arms bristling with erect arm-spines arranged in dense comb-like masses. It has never since been seen, nor has any related form been discovered so far as I can determine. Of the only two specimens extant, one is in the British Museum, the other in the Museum of Comparative Zoology, Harvard.

Through the courtesy of Captain A. Black, Mr. W. H. Dawbin, of this Department, was able to dredge in Pelorus Sound in December 1951, when he obtained three specimens of an amphiurid, the affinities of which were not at first obvious. It differed remarkably from any other known New Zealand form. I now find that the Pelorus specimens (which were taken in 25–30 fathoms) conform in most respects with *Ctenamphiura maxima*, differing chiefly in the fact that the under surface of the disk is partly naked, and in the presence of only a single very large tentacle scale; also the massive arm-combs diminish in size on the proximal few plates. There seems no doubt that the species must be closely related to *C. maxima*, and, as the distinguishing features mentioned are diagnostic, it may take the name *Ctenamphiura dawbini* sp. nov. The type will be placed in the museum of this Department, and a full description, with figures, will appear in the "Zoology Publications from Victoria University College". Fortunately, the species comes from an accessible locality, from which, therefore, there is every likelihood of further material being obtained in the near future. It is hoped that at least a limited amount of material will soon be available for distribution to those museums which maintain important echinoderm collections.

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Correlation Study of Bovine Erythrocyte Antigen *A* and Butterfat Test

Ferguson[1], in a discussion in a paper entitled "Heritable Antigens in Erythrocytes of Cattle", raised the possibility that certain of these cellular antigens may be used as 'markers' in a study of the inheritance of complex physiological characters such as milk production. Filmer (personal communication) suggested that the most logical antigen production factors to test would be antigen *A* and butterfat test, because of the direct correlation between high frequency of antigen *A* and of high butterfat test in Jersey, and low frequency of antigen *A* and low butterfat test in Friesian cattle. Owen *et al.*[2] reported that 87·6 per cent of a group of Guernsey and 46·1 per cent of a group of Holstein Friesian cattle carried antigen *A*. Stormont (personal communication) mentioned that the frequency of antigen *A* in Jersey cattle is similar to that of Guernsey cattle. Results from New Zealand showed a frequency of antigen *A* in Jerseys and Friesians of an order similar to, but lower than, Owen's Guernsey and Friesian frequencies.

A survey on the lines suggested by Dr. Filmer was carried out in 1951. From nine herds of pedigree Friesian cattle, 95 blood samples were obtained from the 5 per cent of each herd with the highest butterfat test and the 5 per cent of each herd with the lowest butterfat test. Test records for the season 1949–50 were supplied by the New Zealand Dairy Board.

Results.

Highest 5 per cent of each herd had a butterfat test of 3·9 per cent or more.
Lowest 5 per cent of each herd had a butterfat test of 3·7 per cent or less.
Average test of all cows from which samples received, 3·84 per cent (range 2·8–5·0 per cent).
Number of animals with high butterfat test, 45. Frequency of antigen *A*, 0·27. Average butterfat test, 4·33 per cent (3·9–5·0 per cent).
Number of animals with low butterfat test, 50. Frequency of antigen *A*, 0·22. Average butterfat test, 3·36 per cent (2·8–3·7 per cent).
Overall frequency of antigen *A*, 0·24.
Cows with antigen *A*, 23 cows. Average butterfat test, 3·88 per cent (3·2–4·4 per cent).
Cows with high butterfat test, 4·23 per cent (3·9–4·4 per cent).
Cows with low butterfat test, 3·51 per cent (3·2–3·6 per cent).
Cows without antigen *A*, 72 cows. Average butterfat test, 3·82 per cent (2·8–5·0 per cent).
Cows with high butterfat test, 4·38 per cent (3·9–5·0 per cent).
Cows with low butterfat test, 3·34 per cent (2·8–3·7 per cent).

The test serum (Wallaceville anti-*A*) gives similar reactions to the Wisconsin *A*, kindly supplied by Dr. C. Stormont, but is less sensitive, that is, it does not react to quite so many bloods as does the Wisconsin *A*.

From the results, it appears there is no direct correlation between antigen *A* and butterfat test in the Friesian cattle under test. Even though the number of animals is small, it is likely that these results can be applied to Friesian cattle in general.

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Toxicity of Methylene Blue to *Leptospira icterohæmorrhagiæ*

Yanif and Avi-Dor[1] have reported that very low concentrations of methylene blue (0·5 μgm./ml.) inhibit the growth *in vitro* of *Bact. tularense*, but that this dye had no effect *in vivo*; "doses of 0·5 gm. [0·5 mgm. ?] each, applied intraperitoneally for three successive days, did not protect mice infected even with low doses (1–10 LD_{50}) of the bacterium".

So once again methylene blue has been found useless as a chemotherapeutic agent; and yet, in a sense, it may be regarded as the foundation stone of modern chemotherapy. As early as 1871 Ehrlich, the father of chemotherapy, had found that methylene blue preferentially stained malaria parasites, leaving the red blood cells and other tissues unstained; and in 1891 Guttmann and Ehrlich[2] reported that it had a slight anti-malarial action. Their finding was the starting point of the investigation that led to the

discovery of 'Pamaquin', the first synthetic antimalarial. Later, Ehrlich and Hata[3] found that *in vitro* methylene blue was very toxic to the spirochætes of relapsing fever, but that *in vivo* it had no effect on the course of the disease in mice.

It seemed of interest to try the effect of methylene blue on a different genus of spirochætes, the leptospires, which have different growth requirements and a different distribution in the body. The test organism was *Leptospira icterohæmorrhagiæ*. *In vitro*, the organisms were immobilized and killed by very low concentrations of methylene blue (2 μgm./ml.); but *in vivo* doses of 10 μgm./gm. intraperitoneally on two successive days failed even to prolong the life of the test guinea pigs. The strain of *L. icterohæmorrhagiæ* used was highly virulent, and killed guinea pigs in four or five days. It is still possible that methylene blue might be effective in clearing the leptospires from the kidney tubules in cases of chronic infection; but this remains to be tested.

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Phosphorus as a Factor Preventing DDT-Dehydrochlorination

Dehydrochlorination of DDT by certain chemicals concerns not only agriculture[1] but is also of great importance in anti-mosquito campaigns. A major factor here is the time during which DDT, sprayed on walls of houses, retains its insecticidal power. It has been shown[2] that great differences may exist between apparently identical walls, and that iron and aluminium ions are responsible for rapid dehydrochlorination. The difference in the percentage of mosquitoes killed on wooden and *pisé* walls, as reported by Wilkinson[3], might perhaps be explained on these lines.

In the Katanga Province of the Belgian Congo, I. Vincke also observed a rapid loss of insecticidal power of DDT on the walls of certain African houses. He asked us to investigate the problem. Using a modification of the method of Fleck and Haller, we also found that dehydrochlorination of DDT is related to the presence of iron and aluminium ions.

Analyses of soils from different parts of the Katanga have established the following facts: (1) in positive soils (causing rapid dehydrochlorination) there are ferric ions and few, if any, ferrous ions. Occasionally some slight traces of phosphate are found. (2) Negative soils contain both ferrous and ferric ions; the total iron content is generally higher than in positive soils. There is always a certain amount of phosphate.

Owing to a possible action of phosphate in neutralizing ferric ions by complex building, we have tried to use phosphorus to diminish the action of positive soils.

Laboratory experiments with water-soluble phosphorus salts, such as potassium hydrogen phosphates and ammonium phosphate, have given excellent results. Soils which dehydrochlorinized DDT completely after 12, 15, 17 and 20 min. respectively did not liberate any chlorine after 90 min. when previously treated with a normal solution of such phosphates. Similar results were obtained with less positive soils which, before treatment, dehydrochlorinized 20 per cent of the DDT after 90 min.

Tests on the coating of positive walls also showed that a phosphate spray delayed the dehydrochlorination of DDT for an appreciable time.

Using the biological tests of Downs *et al.*[2], we can conclude that in almost all cases the insecticidal power of DDT sprayed on walls may be prolonged by previous spraying with a normal solution of a phosphate.

This method has already been applied on a large scale by Vincke in the Tanganyika district of the Congo.

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Counting Soil Algæ by Direct Fluorescence Microscopy

The dilution technique is not entirely satisfactory in studying soil algæ. There is no universal medium for their growth, nor can we assume that all species will grow on any artificial medium now in use. The slow growth of algal colonies involves delays of up to two or three months, causing inconvenience in routine work. Filamentous and colonial algæ introduce further difficulties. A single filament or colony can give one or many colonies according to the number of viable pieces formed from it during dispersion. Available data on the number of algæ in the soil cannot therefore be regarded as absolutely certain.

Only direct microscopy can resolve these difficulties. Its use has been limited by the small numbers of algæ present (sometimes only a few thousands per gram of soil). This involves counting many microscopic fields, and the difficulties are increased by the small size of some algal cells and by their frequent intimate association with soil particles. A new fluorescence technique is proposed to overcome these difficulties.

All active algal cells are believed to contain at least one of the different chlorophylls. (We reserve the question of resting stages which can lose their chlorophyll.) The red fluorescence of chlorophylls illuminated with blue or ultra-violet light can be used for detecting and counting algal cells by the following technique. The soil suspension is illuminated, through a condenser (1·4 aperture), by a 12-volt or 6-volt lamp, the light of which passes through a solution of copper sulphate in aqueous ammonia. A yellow filter below the eyepiece is used to absorb blue light. Objectives of 10× or 20× are used with a 5× eyepiece. Algæ appear as red spots or lines against a black background. Soil particles are usually invisible, but sometimes give a yellow or green fluorescence readily distinguishable from that of chlorophyll. Using a special slide with a depression of 0·1 mm. deep, the amount of soil examined is a function of the area of the field, and the number of algæ per gram of soil can easily be calculated.

This rapid and direct technique requires neither expensive apparatus nor lengthy culture methods. It counts all soil algæ without selection.

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Formation of New Cell Walls in Cell Division

In a recent communication in *Nature*, further evidence was presented by Dr. E. Elliot[1] relating to the concept of Giltay[2], and supported afterwards by Priestley and Scott[3], that at cell division each daughter protoplast secretes a continuous wall around itself. The suggestion was also made that this method of cell-wall formation may prove to be general in the higher plants. Recent work in this laboratory on cell division in the cambium of angiosperms and gymnosperms further supports this suggestion.

Parts of an enveloping parent wall, apparently persisting after division in the ray initials, were observed connecting adjacent cells of a radial file of ray parenchyma cells isolated by simple maceration (Fig. 1). An example, which may perhaps be more important, was observed in the course of a study of the sequence of cell division of the cambium during the development of compression wood in conifer stems. Thin, feebly birefringent membranes, considered to be the remains of the parent cambial cell wall, were detected traversing the well-developed intercellular spaces characteristic of this tissue (Figs. 2 and 3). In normal wood the presence of similar membranes was demonstrated by careful delignification of thin cross-sections by alternate treatments with chlorine water and alcoholic monoethanolamine, with dilute alcoholic acetic acid washes (Fig. 4). Using techniques of simple maceration, demonstration of the parent wall was extremely difficult, as in the mature tissue this wall is not continuous around a radial file of cells and any slight agitation was sufficient to cause the cells to separate. That only fragments of the parent wall can be demonstrated is consistent with the great radial expansion of the cambium daughter cells which occurs during differentiation, following periclinal divisions.

A further point of interest is that the parent wall could not be demonstrated at the tips of cells by either of the techniques referred to above. This may be an indication of tip growth rather than of symplastic readjustment of the cells following cell division in the cambium.

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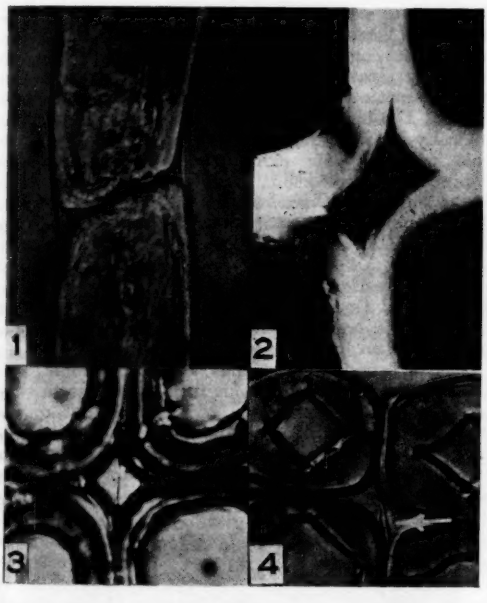

Fig. 1. *Grevillea robusta*. Part of two ray parenchyma cells, isolated by maceration with hydrogen peroxide and acetic acid, showing part of parent wall of the ray initial. Unstained. × 980

Fig. 2. *Pinus pinaster*. Transverse section of compression wood between crossed nicols. Only part of the parent wall traversing the intercellular space is in a position of brightness. × 2,000

Fig. 3. *Pinus pinaster*. An example similar to Fig. 2, photographed with ordinary illumination after staining with safranin. × 980

Fig. 4. *Pinus pinaster*. Transverse section of normal wood after delignification showing parts of the parent wall (marked by arrow). Unstained. × 430

Sugarcane × Bamboo Hybrids

Sugarcane × bamboo hybrids were first reported from this Institute by Venkatraman in 1937[1]. In spite of the absence of easily recognizable bamboo characters in the seedlings, Kutty Amma and Ekambaram[2] proved by a critical study of the anatomy and morphology of the seedlings that they were genuine hybrids. This corroborated Janaki Ammal's[3] conclusion arrived at earlier, on the basis of somatic chromosome counts. In these bamboo crosses the pistillate parents employed were the two male sterile Java canes, *POJ*.213 and *POJ*.2725. These were themselves complicated bispecies hybrids —*POJ*.213, involving *S. officinarum* and *S. barberi*; *POJ*.2725, a much more complicated hybrid between a number of *officinarum* and Java *spontaneum* (Glagah). It was felt desirable to repeat the cross, using a simple *officinarum* as the female parent. All the varieties of *officinarum* so far examined show $2n = 80$. For this purpose, *S. officinarum* var. *Vellai* (a local form) was employed and two seedlings were obtained. Examining the mother and the two seedlings derived therefrom through pollination with bamboo, one of the seedlings is very thick, much thicker than the mother, more vigorous and taller. The other is much thinner. Examination of the root-tips revealed a somatic chromosome number of 116 in the thick seedling and 86 in the thin. It is believed that the thick seedling has come into being through the fusion of an unreduced egg of *S. officinarum* (that is, $2n = 80$) with a normal sperm of *Bambusa arundanacea* ($n = 36$). The thin seedling

has presumably been formed by the union of an *officinarum* egg having neither the haploid nor the diploid number, with the sperm of bamboo. Functioning of diploid eggs in interspecific and intergeneric crosses, involving *Saccharum*, especially the species *officinarum* as one of the parents, is not an infrequent phenomenon. Almost all interspecific hybrids between *S. officinarum* × *S. spontaneum* have come into being through the operation of the unreduced egg of *officinarum*. Some cases of intergeneric hybrids are known where both the haploid and diploid eggs have functioned in the same cross. The latest known case is that of *S. officinarum* var. *Vellai* × *Narenga* ($2n = 30$), where hybrids showing $2n = 95$ and $2n = 55$ have been obtained (Raghavan unpublished). Functioning of egg with unexpected chromosome number in the formation of sugarcane hybrids is less common. While one such case is known involving a bicomplex hybrid as the pistillate parent, recent investigations have shown that this feature is shared by simple *officinarum* also. For *Co.*453, which is a cross between *S. officinarum* var. *Zw. cheribon* ($2n = 80$) and *Co.*285 ($2n = 112$), showed a chromosome number of 124, indicating that *Zw. cheribon* has contributed through its egg neither the haploid number (40) nor its unreduced number (80) but an unexpected number, that is, 68 [4]. This report is of interest in three particulars. First, instead of complicated bi-species or tri-species, derivatives such as *POJ.* or *Co.* canes, a simple *officinarum* has been employed as the pistil parent. Secondly, viable embryos are obtained from fertilization of not only haploid gametes, as reported by Janaki Ammal[3], but they are also formed from fertilization of unreduced eggs by normal sperms. This brings these bamboo hybrids into a line with *Saccharum* × *Sorghum* hybrids, in the formation of which also both reduced and unreduced eggs have been known to function[5]. Thirdly, the operation of an egg with unexpected chromosome number in the cross has also been vouched for.

Though the gross resemblance of the seedlings is to the mother, namely, sugarcane, the presence of such characters as arched root eyes above nodal buds of peculiar shape and disposition, extra-vaginal nature of the bud piercing the leaf-sheath, the mode of underground branching—these and other features, taken together with the chromosome number, leave very little doubt as to the genuineness of the cross. Perhaps this preponderance of maternal characters may be explicable on the basis of cytoplasmic inheritance, the existence of which was reported by Raghavan[4] in a number of interspecific hybrids in *Saccharum*.

A study of the intergeneric hybrids of *Saccharum*, which is now in progress, makes one believe that the seemingly conflicting phenotypic configurations obtained in several crosses are a result of the interaction of the plasmon with the genes. They seem to support the theory of the plasmon-sensitive genes in that it offers a reasonable foundation for the interaction of plasmon and genes; the result is that the same genes act differently in different plasmons. It would seem that in sugarcane hybridization more importance should be paid to the mother than to the father in the evolution of economically important seedlings. Also, the absence of fruitful results in the raising of economic seedlings through a particular cross need not be final; for it is just as likely that hybridization in the opposite direction, wherever such is possible, may result, through this interaction of the plasmon and the genes, in the expression of a phenotype answering to our needs.

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June 19.

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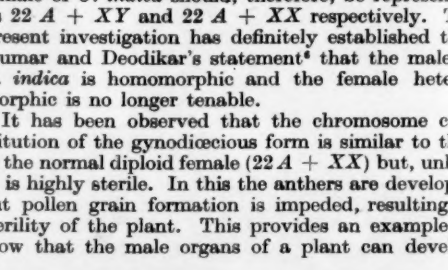
Sex Mechanism in *Coccinia indica* Wight and Arn.

Some of the dicœcious species of Cucurbitaceæ have been cytologically investigated by several previous workers to ascertain whether the morphological differences in flowers between the sexes could be correlated with any observable chromosomal differences of their gametes. So far, only two species among members of this family, namely, *Trichosanthes japonica*[1-3] and *Coccinia indica*[4-6] have been found to possess well-defined sex-chromosomes. In *T. japonica*, the male is reported to be the heterogametic sex, whereas in *C. indica* contrary evidences have been furnished by Kumar and Deodikar[6] and Bhaduri and Bose[4]. The present note is based on the results of a critical cytological investigation of different sex types, such as the diploid male and female, the gynodiœcious form and a triploid male of *C. indica*.

A careful examination of the somatic complement in diploid male (Fig. 1,*a*) and female (Fig. 1,*b*) and of meiotic complement in pollen mother cells has definitely established that male of *C. indica* is the heterogametic sex with XY type of sex-chromosomes. Of this, Y is bigger than X while the latter is morphologically similar to the autosomes. During meiosis this unequal pair exhibits heteropycnosis, non-congression, precocious segregation, etc., which behaviours are characteristic of sex-chromosomes. The chromosome constitution of the male and the female of *C. indica* should, therefore, be represented as $22\,A + XY$ and $22\,A + XX$ respectively. The present investigation has definitely established that Kumar and Deodikar's statement[6] that the male of *C. indica* is homomorphic and the female heteromorphic is no longer tenable.

It has been observed that the chromosome constitution of the gynodiœcious form is similar to that of the normal diploid female ($22\,A + XX$) but, unlike it, is highly sterile. In this the anthers are developed but pollen grain formation is impeded, resulting in sterility of the plant. This provides an example to show that the male organs of a plant can develop



(*a*) (*b*) (*c*)

Fig. 1 (*a*), (*b*), (*c*). Somatic complement of diploid male and female and triploid male respectively. (× 1,100)

even in the absence of Y chromosome. It further shows that there is something in the Y chromosome which is necessary for the production of gametes but which is absent in the X chromosomes and the autosomes.

A clone of a male plant conspicuous for its vigorous and extensive growth, when cytologically examined, has proved to be a triploid with 36 chromosomes (Fig. 1,c). Of these, one is large and very similar to the Y chromosome observed in the diploid male, while all the rest are small and nearly alike. This Y, with which two other chromosomes are associated during meiosis, constitutes the XXY trivalent. The Y is clearly distinguishable from the rest of the chromosomes on account of its distinct size, shape and behaviour. Thus from a knowledge of the chromosome constitution in diploids and this triploid ($33\,A + XXY$), it is quite evident that the influence of Y is so overwhelming that the triploid, in spite of the presence of two X chromosomes, has become a perfect male plant. This lends further support to the suggestion made that the Y chromosome contains some element which is necessary for the formation of gametes.

The occurrence of a triploid male reported here for the first time shows that polyploidy exists within the species *C. indica*.

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Feb. 20.

[1] Lindsay, R. H., *Amer. J. Bot.*, **17**, 152 (1930).
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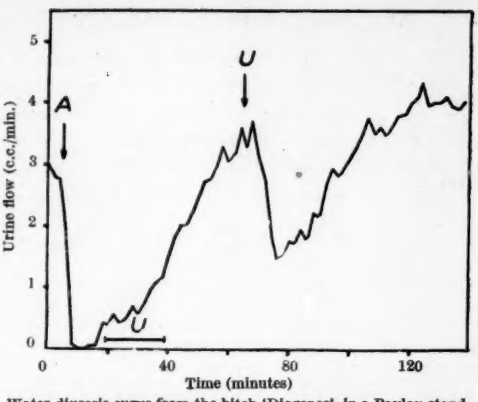
Adrenaline-Antidiuresis in the Water-loaded Dog

Intravenous injection of small doses of adrenaline has been observed to cause a temporary reduction of the flow of urine in water-loaded dogs[1,2]. According to Pickford and Watt[2], this action of adrenaline is dependent on alterations in renal blood pressure and flow. We believe we have obtained evidence for the release of the antidiuretic hormone by moderate doses of adrenaline.

After a fasting period of about 18 hr., in the course of which water was given *ad lib.*, 30 c.c. of tap water per kgm. of body weight was introduced into the stomach of a dog. A similar dose of water was given 1½ hr. later. Urine flowing through the inserted catheter was collected in graduated tubes and measured every 2 min. After the beginning of steady flow, doses of adrenaline varying from 0·008 mgm. to 1 mgm. were administered intravenously. The dogs were unanæsthetized during the experiments.

Adrenaline in doses of about 0·01 mgm. induced a typical short adrenaline-antidiuresis as earlier described by Verney[1]. Injection of doses of 0·04–0·2 mgm. was followed by a biphasic antidiuresis. First, a rapid transitory inhibition of the flow of urine of the adrenaline-type appeared. Thereafter, a more prolonged inhibition, resembling that caused by the antidiuretic hormone[1], began and reached the maximum at about 20 min. from the time of the injection.



Water-diuresis curve from the bitch 'Diogenes', in a Pavlov stand. At $A\downarrow$, 0·5 mgm. adrenaline was injected intravenously. Urine was collected at U—, and re-injected at $U\downarrow$

If 0·5 mgm. or more of adrenaline was injected, the antidiuresis was either mono- or bi-phasic. In the monophasic reaction, as is seen from the accompanying graph, the rate of flow of urine rapidly decreased to zero, increased gradually, and reached the pre-injection level in about 40–60 min.

The mechanism of this antidiuretic effect of adrenaline is not yet clear. However, the form of the curves suggests the possibility that moderate doses of adrenaline may cause, besides a rapid inhibition of flow of urine typical of this substance, a release of the antidiuretic hormone from the posterior pituitary. To investigate this possibility, urine collected during the period of adrenaline-antidiuresis was intravenously injected into the same dog. This urine was observed to have a pronounced antidiuretic action, as demonstrated in the graph. Control samples collected during uninfluenced diuresis for similar periods did not produce any comparable inhibition of flow of urine. An inhibition of the observed magnitude can be obtained with a dose of 0·1–0·2 mgm. of adrenaline. However, the excretion of some 20–40 per cent of the total amount of adrenaline injected in the course of 20 min. appears unlikely. Adrenaline alone is therefore scarcely likely to be responsible for this antidiuresis. On the other hand, the antidiuretic hormone is in part quickly excreted and can be detected in small amounts of urine, as observed by O'Connor[3], whose technique was adopted in this study. Hence the effect of the urine excreted during the adrenaline-antidiuresis supports the view that the prolonged stage of this antidiuresis is due to the release of the antidiuretic hormone. Direct evidence is, nevertheless, still lacking. In view of the fact that small doses of adrenaline inhibit the release of the antidiuretic hormone as induced by various stimuli[1], the eventual converse effect of larger doses is of special interest.

More detailed description of the results will be published elsewhere.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ASSISTANT IN STATISTICS—The Secretary, The University, Aberdeen (August 30).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (August 30).

CHEMIST (Experimental Officer grade) in the Fungicide and Insecticide Research Co-ordination Service in London—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 30).

SENIOR ASSISTANT ENGINEER (Chemist) (with an honours degree in chemistry, or a degree with chemistry as a principal subject) for work on the technical aspects of pollution of water-ways of all kinds and the treatment of natural waters for the prevention of slimes and deposits in heat-exchangers—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/274 (August 30).

ASSISTANT BIOCHEMIST to work at the Group Laboratory, Warwick Hospital, and at the King Edward VII Memorial Sanatorium—The Pathologist, Group Pathological Laboratory, Lakin Road, Warwick (August 31).

ASSISTANT EXPERIMENTAL OFFICER (with a degree in horticulture and an interest in horticultural research, especially regarding the preparation and handling of horticultural produce for marketing) to investigate the effects of washing of vegetable produce—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (September 1).

ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Secretary, University College, Earlsfort Terrace, Dublin (September 1).

ASSISTANT LECTURER IN MATHEMATICS (with special qualifications in pure mathematics)—The Registrar, The University, Manchester 13 (September 6).

ASSISTANT LECTURERS (2, one of whom at least should have qualifications in general mycology or microbiology) IN THE DEPARTMENT OF BOTANY—The Secretary, University College, Gower Street, London, W.C.1 (September 6).

LECTURER IN ELECTRICAL ENGINEERING—The Assistant Secretary of University Court, The University, Glasgow (September 6).

SCIENTIST III or SCIENTIFIC TECHNOLOGIST I (with a science degree or equivalent qualification) for the assembly, recording and reporting of scientific data on coal seams, at the Coal Survey Laboratory at Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/518 (September 6).

SENIOR LECTURER or LECTURER IN CROP PRODUCTION, in the Department of Agriculture, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 6).

LECTURER IN BOTANY (qualifications in plant physiology essential)—The Secretary, The University, Aberdeen (September 8).

LECTURER IN PARASITOLOGY in the Department of Zoology—The Secretary, The University, Edinburgh (September 8).

ASSISTANT (with interests on the physical and inorganic side) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Aberdeen (September 10).

LECTURER (with an honours degree in physics, with research experience, and interested in the design of optical, electronic and pressure-recording apparatus) IN BIOPHYSICS—The Secretary, The University, Edinburgh (September 10).

DISTRICT (Forest) OFFICERS—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 146/52 (September 11).

LECTURER (Grade I or II) IN PHARMACEUTICAL CHEMISTRY, and a LECTURER (Grade II) IN AUTOMOBILE ENGINEERING AND VEHICLE TECHNOLOGY, at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 12).

ASSISTANT KEEPER (Geology)—The Director, Museums and Art Gallery, Leicester (September 15).

ASSISTANT LECTURER IN CHEMICAL ENGINEERING, an ASSISTANT LECTURER IN FUEL TECHNOLOGY, and an ASSISTANT LECTURER IN GAS ENGINEERING—The Registrar, The University, Leeds 2 (September 17).

PRINCIPAL SCIENTIFIC OFFICER at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a team engaged on the thermodynamic tables programme of the Heat Division—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4161/52 (September 18).

RESEARCH STUDENTSHIP IN MATHEMATICS, and an ASSISTANT LECTURER IN MATHEMATICS—The Professor of Mathematics, University College of North Staffordshire, Keele, Staffs (September 20).

ASSISTANT AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture)—The Registrar, The University, Bristol (September 30).

SENIOR LECTURER and a LECTURER IN ANATOMY, and a SENIOR LECTURER IN BACTERIOLOGY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 30).

SENIOR RESEARCH SCIENTIST (with a wide knowledge of physical chemistry and/or biochemistry) for a research post which will also involve a considerable degree of supervision of the work in progress in the Association's laboratories—The Director of Research, Baking Industries Research Station, Chorleywood, Herts (September 30).

LECTURER (Grade II) IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15 (October 1).

SENIOR LECTURER IN GENERAL CHEMISTRY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

DEPUTY EXECUTIVE OFFICER (with a recognized degree in agriculture or natural science) OF THE SEED PRODUCTION BRANCH, a REGIONAL TRIALS OFFICER (with a University degree or diploma in agriculture and/or biology) (to be stationed at the Harper Adams Agricultural College, Newport, Shropshire), and an ASSISTANT (with a recognized degree in agriculture or natural science) to the Mycologist—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

EDUCATIONAL PSYCHOLOGIST (part-time) (honours graduate in psychology)—The Medical Director, Child Guidance Training Centre, 6 Osnaburgh Street, London, N.W.1.

ELECTRICAL ENGINEERS (Senior Scientific Officer grade) for work connected with the design and development of remote power controlled gear and servo mechanisms, at a Ministry of Supply Design Establishment near Sevenoaks—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.329/52A.

EXPERIMENTAL OFFICER IN THE RADIO RESEARCH ORGANIZATION at Teddington, for abstracting scientific and technical articles on radio research and development—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.268/52A.

LECTURER IN MECHANICAL ENGINEERING (including heat engines and hydraulics)—The Principal, Faraday House College, Southampton Row, London, W.C.1.

MATHEMATICIAN or PHYSICIST (Principal Scientific Officer grade) at a Ministry of Supply Design Establishment near Sevenoaks, to lead a section dealing with mathematical/physical investigations, including theoretical aspects of design problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.220/52A.

MECHANICAL ENGINEERS for research work connected with the preparation of airframe Appendices A at Ministry of Supply London headquarters—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.493/52A.

RESEARCH ENGINEER (with B.Sc. or equivalent, and some engineering workshop and drawing office experience essential) for design and testing of experimental equipment—The Assistant Secretary, British Coal Utilization Research Association (Ref. No. A.19), Randalls Road, Leatherhead, Surrey.

SENIOR SCIENTIFIC OFFICER (Veterinary Research) at the Central Trypanosomiasis Institute, Sukulu, Uganda, to undertake research in animal trypanosomiasis—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27066/84/52.

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